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LOADING ORE AT KALGOORLIE, AUSTRALIA

A Monthly Publication Devoted to the Many Fields of Endeavor in which Compressed Air Serves Useful Purposes

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EDITORIAL CONTENTS

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A MEAL IN GLASS

Cooking in glass would have been rightly considered foolhardy when grandma was a bride. Thanks to the development of a low-expansion glass that will withstand sudden temperature changes, everything from the meat course to the after-dinner coffee can now be prepared in transparent utensils, and served in them also. Curiously enough, things cook more quickly in glass than in metal. Some of the new decorated Pyrex dishes now available are shown below.

Increasing the Usefulness of Glass

C. H. VIVIAN

ALTHOUGH the making of glass is among the oldest of the industrial arts, it still offers one of the greatest fields for research. As one authority lately put it, "Not even the easy things have all been done in glass, and help is needed from those who like to do hard things." Apparently, then, the many wonderfully interesting developments in glassmaking during recent years are but forerunners of even more marvelous accomplishments to come.

Last March the attention of the world was drawn to American glass craftsmanship by the casting of a 201-inch telescope mirror disk at the Corning Glass Works in Corning, N. Y. This was in itself a feat of distinction, but even more remarkable was the fact that it could be done in this country. For the glassmaking art is steeped in experience and tradition, and until of late years only the European centers, which have for generations specialized in optical glass, would have been capable of turning out an article of such fineness and exactness. This is not to say that we had no glass industry of importance in the United States until recently. As a matter of fact, a glass plant was among the first manufactories established on these shores, Capt. John Smith and his colonists having made haste to erect one when they discovered that glass beads so fascinated the Indians that they would eagerly accept them in exchange for furs and other valuable materials.

From this modest beginning in 1608 there has sprung a huge glass-producing business whose annual output is now valued at more than $200,000,000. With few exceptions, however, the canny Yankee glassmaker remained content to turn out the more ordinary wares that lent themselves to mass production. It was he that developed and exploited machinery for pressing glass into intricate patterns that were previously obtainable only by laborious hand cutting. American inventiveness likewise gave the world bottle-blowing machines and other power-operated appliances that tended to regiment glassmaking—to transform it from a handicraft into an industry. In justice to these developments and to the men responsible for them, it should be recorded that they constituted a practical contribution to civilization, for had they not come to pass we should even now perhaps not be able to discard an empty bottle with no thought as to its cost. However,

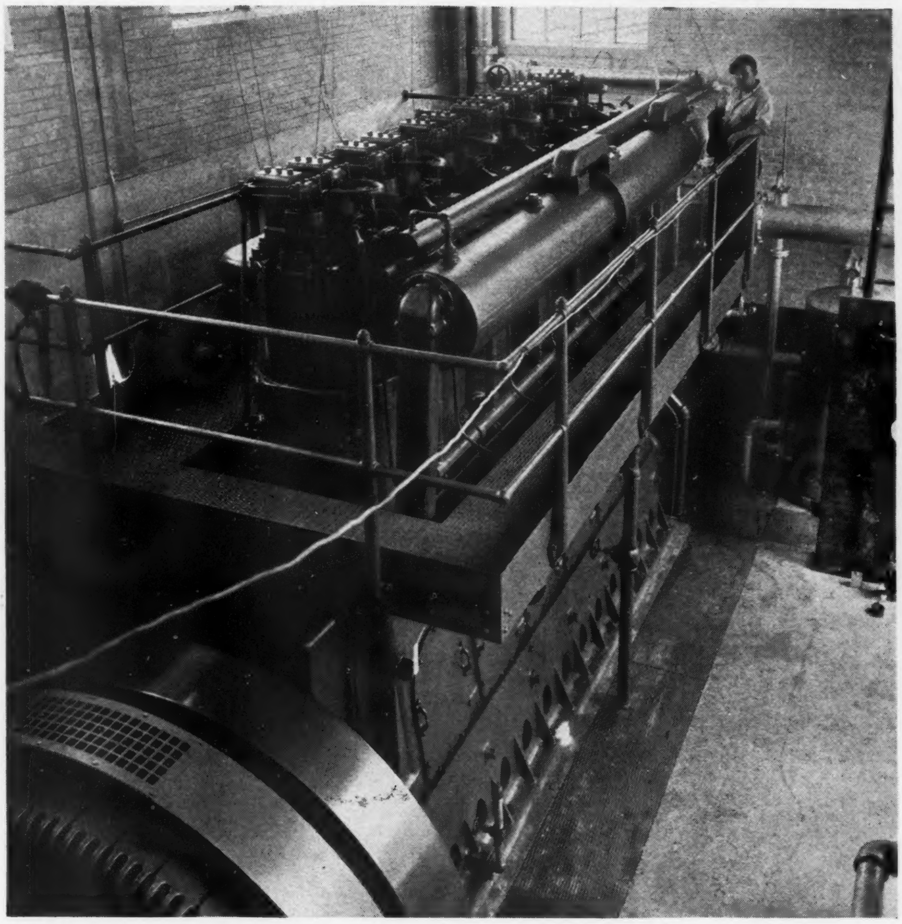
the fact remains that the art of producing fine glass was left more and more to European craftsmen. Most of us can bear witness to this by recalling that as recently as 1917 we were urged to turn over to the Government our opera glasses and field glasses, it having been found that American plants were not prepared to produce the high-grade optical glass which was vital to the business of waging war. Such glass had always been obtained from abroad.

But with glass imports cut off during the war, Yankee ingenuity quickly asserted itself. American manufacturers not only contrived to turn the trick of duplicating European specialties but, while they were about it, they developed some new forms of glass and discovered some new uses for glass that not even the Old World artisans had thought of. The war thus proved a stimulus to our fine-glass industry, indicating that, in business as in nature, a thing of beauty may sometimes emerge from an ugly chrysalis.

While our present story is concerned primarily with the Corning Glass Works, it is of interest to note, in passing, what happened in the case of optical glass. Thanks to the foresight of William Bausch, the well-known Bausch & Lomb Optical Company had experimented sufficiently to enable it, with the assistance of the Geophysical Laboratory of the Carnegie Institution, to turn out quickly suitable varieties of glass for high-precision gunsights, range finders, periscopes, field glasses, and other instruments. That one firm supplied the Government, in less than two years, with 450,000 pounds of such glass, or about 70 per cent of the total furnished from all sources.

The Corning Glass Works was one of the outstanding exceptions to the general run of glass producers. From its founding, in 1858, it had always leaned toward the making of special composition glasses, and had learned the value of research even before the war clouds gathered. It has been said that where the average glass plant leaves off Corning begins. It was only natural, then, that it should make much headway under the impetus of the embargo on imports. One of its newer products at the time was a series of low-expansion glasses which, as early as 1915, it sold under the "Pyrex" trademark. The war served to accelerate their development by opening up to them new fields of application. Had the company been deprived of the vast experience gained through that development, it is doubtful if it would have been able to proceed confidently last spring with the casting of the 20-ton stellar eye which represents the greatest single mass of glass ever made.

Following the armistice, Corning increased rather than reduced its glass research staff. A list of its scientific personnel now reads like the faculty roll of a university, there being on it physicists, chemists, electrical experts, home economists, etc. Their collective duty is to find new applications of glass so that suitable products



GENERATING POWER WITH NATURAL GAS

The immense volume of gas required in processing the glass was formerly manufactured at the Corning Glass Works: now it has been supplanted with natural gas. The 1,200-hp. gas engine shown here drives an 800-kw. generator which furnishes electric power for the plant. It has six cylinders, each 22x26 inches. Ignition is furnished by two Bosch magnetos, and there are two spark plugs to each cylinder.

may be made to fill them, and also continually to check the products already being manufactured to make sure that they will perform adequately the purposes for which they are sold.

As a result of their efforts, the public is being educated in what these experts call the manysidedness of glass. One who goes through the Corning Glass Works learns that glass is somewhat chameleonic: it has a Jekyll and Hyde personality which enables it to satisfy numerous and diverse requirements. One finds out that more than 200 kinds of glass, each having a distinct chemical composition, are being produced in the main plant of the company alone. Some are so different from others that it is difficult to believe they are all members of the same family. Much of the output consists of engineering and industrial materials which are manufactured to definite and rigid chemical and physical specifications. The fragility which is commonly associated with all glass has no place in them. At the same time, another group of products is characterized chiefly by delicacy of structure and artistry of design.

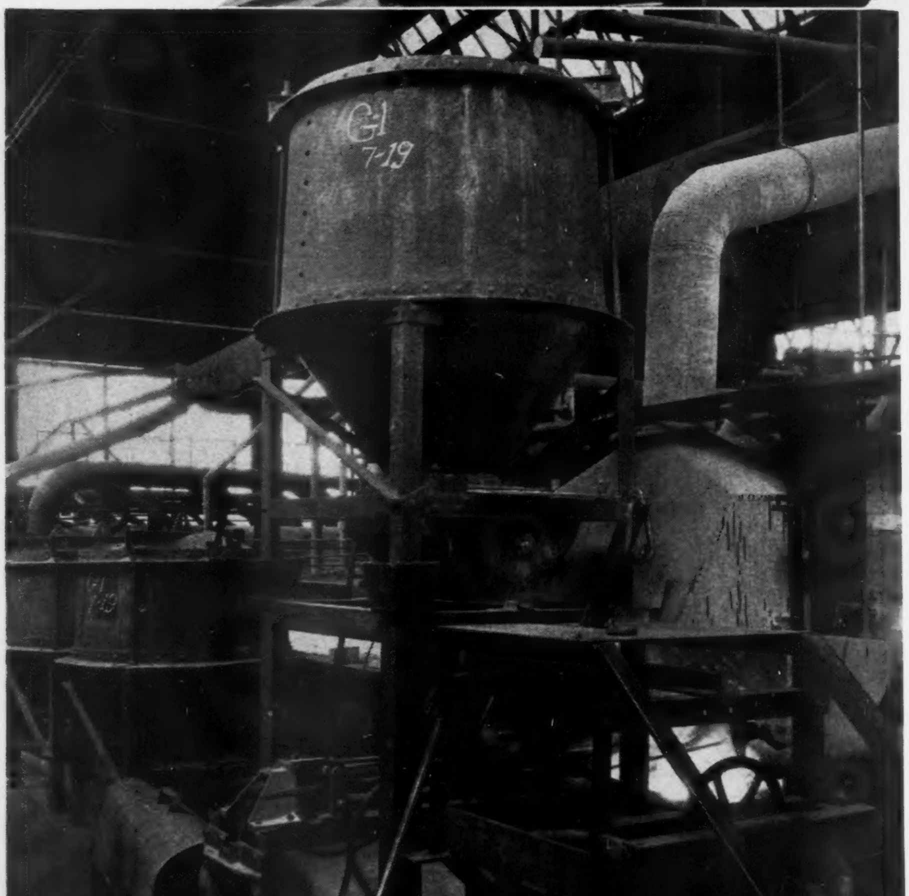
The visitor is further informed that glass has a higher compressive strength than granite, concrete, vitrified brick, or cast iron. Based on laboratory tests, a load of 350 tons would be just sufficient to crush a 2-inch cube of it. Similarly, the tensile strength of certain kinds of glass is around 10,000 pounds to the square inch, indicating that a freight car might be suspended in the air from a bar of it 2 inches square.

Ordinary glass such as that used for windows and bottles is a soda-lime silicate. If the lime is replaced by lead oxide and some of the soda by potash, the product is known as lead glass, or flint glass. Among its properties is brilliancy of luster, and therefore it has been utilized extensively in the manufacture of cut-glass objects. A third important group of glasses consists of borosilicates and contains borax or boric acid, or both. Owing to their resistance to heat and chemical attack, these glasses have enjoyed continually widening fields of application and sale under the name of Pyrex.

By varying the character and the amounts of the raw materials that enter into the mixes, the resulting glasses may be altered throughout a wide range. For instance, the specific gravity of glass may be made to fall between the extremes of

MAKING GLASS TUBING

Millions of miles of glass tubing are now formed annually by ingenious machines. The process is continuous, molten glass issuing over a revolving mandrel to be drawn down to size by an apparatus 150 feet away. Below is shown the rear of the heating tank into which materials are automatically fed by the overhead hopper. The drawn glass is cut into suitable lengths, which are graded for size in the machine pictured at the right.



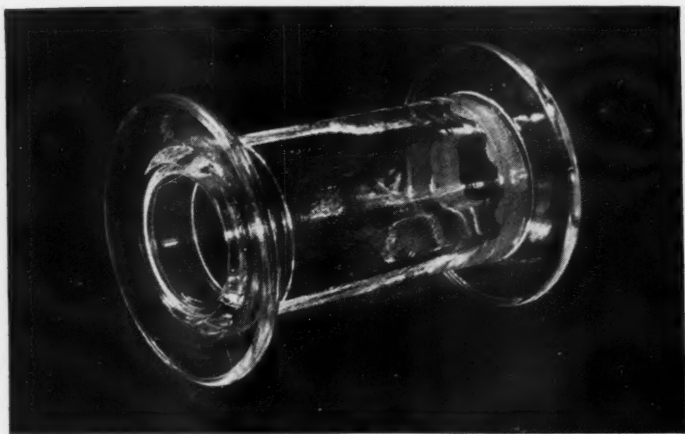
2.14 and 6.33, the latter figure being for a glass containing nearly 80 per cent lead oxide. Similarly, the hardness may be changed at will through a 2 to 1 ratio, with the upper limit approaching the hardness of steel. Heat conductivity is another characteristic which may be varied throughout a 2 to 1 range.

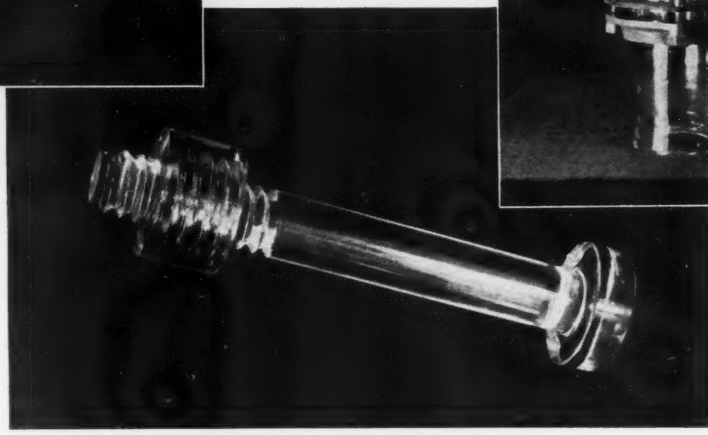
Glass plants which standardize on a few articles naturally adhere to a few standard mix formulas, but at Corning, where special glasses are the rule rather than the exception, diverse combinations of materials are employed. All told, more than 100 different substances, virtually all mineral products, enter into the 200 varieties of glass produced. Hundreds of tons of raw materials are melted each day in the main plant alone. Of these the major proportion is sand—silicon dioxide. It is not natural sand, but crushed sandstone, and thousands of tons of it are used annually. This and other mix constituents such as lead oxide, feldspar, and borax, which are employed in large quantities, arrive in carload lots, are dumped into bins, and elevated to the mixing floor as required. Either because their use is limited, or their value is great, certain other materials reach the plant as express shipments.

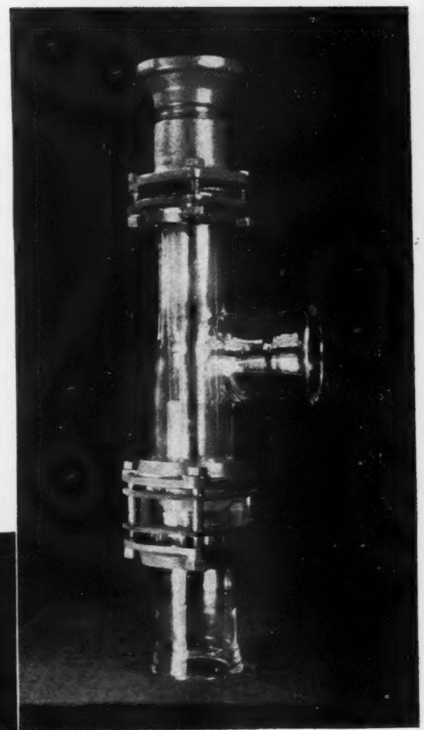
Always present in the raw mix is a considerable amount of cullet, or broken glass. It assists in bringing about the desired chemical reaction, much in the manner that a piece of old dough will prove helpful to the housewife in starting a batch of sourdough bread. There is, thus, virtually no waste in a glass factory. Ware broken during processing, or rejected in the course of the numerous inspections, is all eventually returned to the melting compartments. In the case of borosilicate glasses,

GLASS INDUSTRIAL MATERIALS

Properly prepared, glass has strength and hardness which compare favorably with those of wood and certain metals. It is already an important industrial material, and its use in that field is growing fast. Shown here are a reel employed in the silk industry, a bolt and nut, and a pipe-line valve, all of them of Pyrex glass.







cullet forms a large proportion of the mix.

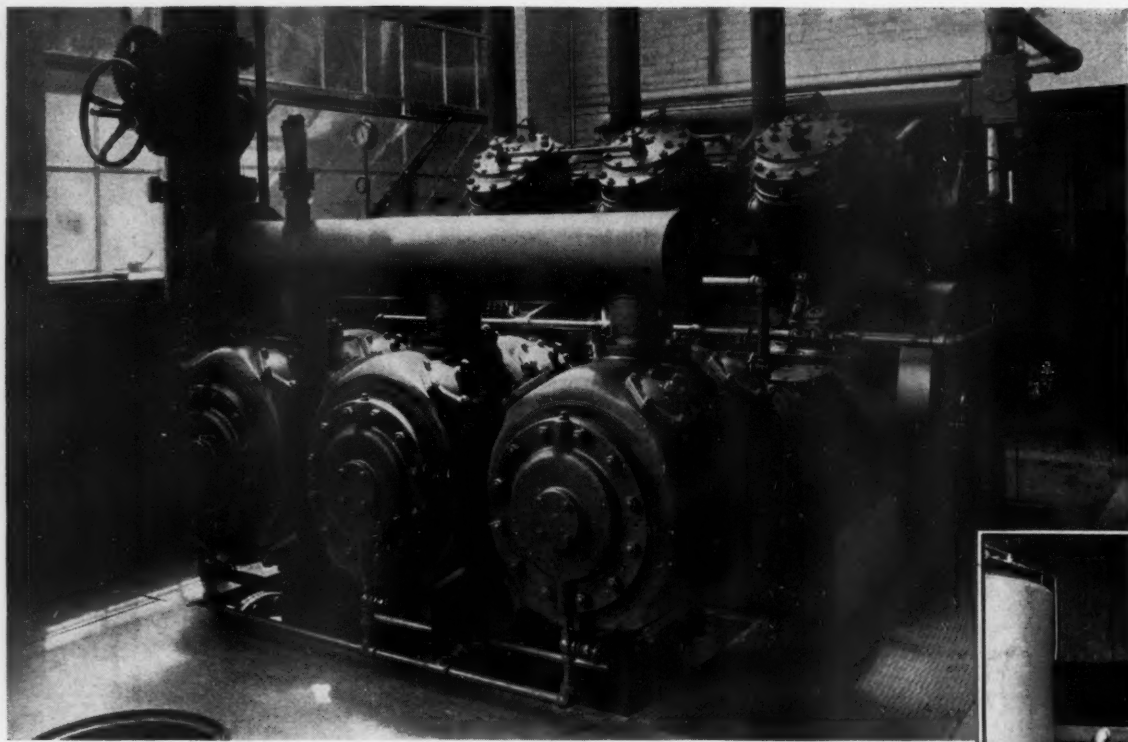
Strange as it may seem, the raw materials are mixed in an ordinary concrete mixer, this apparatus having been found to be the most satisfactory for the purpose. After up to four minutes of tumbling in a 56-cubic-foot motor-driven unit, the mixture is discharged into the steel body of an electric truck for transportation to the point of melting. As an indication of the closeness with which the proportions are controlled, it may be mentioned that in some cases a few grams of certain ingredients are weighed out per ton of batch.

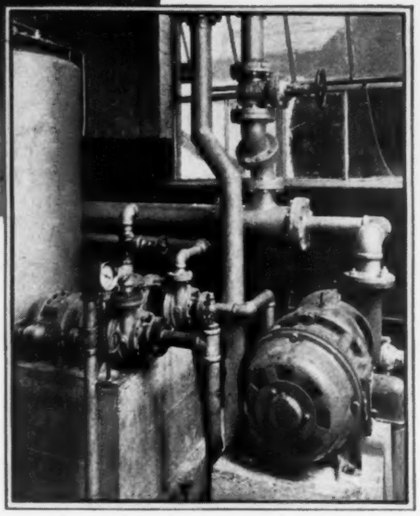
Coloration is one of the interesting but little-known phases of glass technique. The chemical whys and wherefores of color causation are as yet largely speculative, although a wide variety of chromatic effects can be obtained by adding suitable reagents, usually metallic oxides. The peculiar thing about their influence is that a given oxide may produce different colors in different glass mixtures, or different oxides of the same metal may produce different colors in different glass mixtures. For example, nickel imparts a violet color to potash-lead glasses but makes soda-lime mixtures brown. There are, however, four oxides whose color effects are constant. These are the oxides of cobalt, manganese, uranium, and chromium. It may surprise many persons to known that gold is used as the color reagent in certain grades of ruby-red glass employed for making fine tableware and ornamental pieces. In the manufacture of clear glass, one of the problems is to keep color out. Various impurities commonly found in some of the raw materials will tint the mixture if they are allowed to remain. Iron is an habitual offender in this respect, and special apparatus is therefore provided to remove nails and other bits of tramp iron which are inevitably present in materials shipped in carload lots. In some cases substances are added to the mix for the purpose of counteracting coloration by impurities.

The story of the origin of Pyrex glasses has been told in these pages before, but will bear repeating in brief form. Pioneer investigations at Corning in this field resulted in a request for a better lantern globe from the railroads, to which the company had always supplied much ware. Globes then in use often became overheated from the oil flame playing directly on one area, with the result that they broke when suddenly cooled by rain or snow. Sometimes such failures jeopardized human lives. The solution of the problem obviously lay in a glass having a low coefficient of expansion—that is, one which would expand little when heated and contract little when cooled. Such a glass was successfully made and answered well the particular service for which it was intended, but it proved ill adapted for general use because it was slowly but completely soluble in water. Another glass which was more sensitive to temperature variations but which was highly resistant not only to water but to chemicals as well had been developed for the making of battery jars, so the research department set about combining the good features of the two in an effort to produce a super-resistant glass. The result, which was not achieved over night, was a low-expansion glass which is resistant to both heat shock and chemical attack.

The full import of this achievement was not readily apparent, although the research staff was confident all the while that investigations would disclose various uses for the new glass. Its first application of consequence after the original one was in the kitchen, and, with the introduction of glass baking ware, Pyrex became a household word. This service suggested that the new glass might be suitable for the laboratory. At the time, however, this was an unattractive field from a business standpoint, and it was not until importations of glass ceased during the war that the company consented to make some beakers and flasks. These answered the requirements so well that a general line of laboratory ware was developed. This has been extended until it now includes not only standard articles but also special apparatus designed according to individual specifications and produced by skilled artisans who shape intricate forms over the blowpipe with accuracy and deftness which are plainly born of long experience.

It was but a step from laboratory ware to industrial tubing. One factory alone now employs more than eighteen miles of Pyrex tubing for heat-exchange operations. This is one of Corning's most promising fields of expansion. Glass pipe lines offer high resistance to corrosive liquids of all kinds and are not only easy to clean but, what is more important, give instant and visible evidence of their cleanliness. By





MODERN AIR COMPRESSOR

This gas-engine-driven machine is the latest of seven stationary compressors in the main plant of the Corning Glass Works. It has a piston displacement of 2,100 cfm., and is designed for 25 pounds discharge pressure. The smaller picture shows three Cameron "Motorpumps" which handle cooling water for this compressor and for the gas-engine generator set illustrated elsewhere.

virtue of these facts, breweries, food-processing plants, and other establishments which make a point of good housekeeping are using glass in increasing quantities. Pipe lines are furnished for pressures up to 50 pounds per square inch and in diameters up to 12 inches.

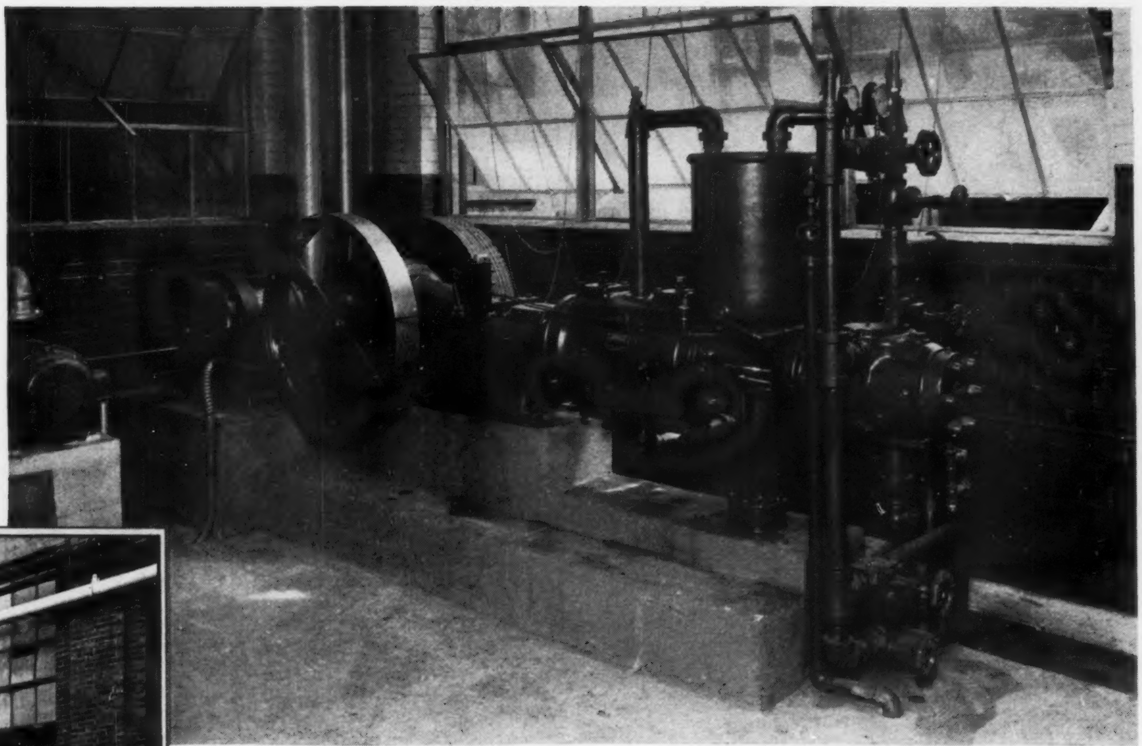
Although Pyrex glasses are best known for their resistance to temperature changes, Pyrex chemical glass has other attributes which are being capitalized in its rapid extension into the industrial field. Its surface hardness is only about three points below that of the diamond, and it will withstand certain kinds of abrasion better than steel. Because of these properties, together with its chemical inertness, it has been found suitable for the making of reels and other equipment in silk and rayon mills, standing up better than the materials previously utilized.

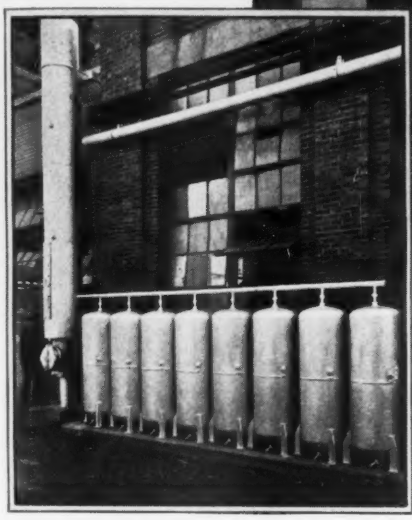
Another important and growing demand for one of the Pyrex glasses is in power-line and radio insulators. For high-tension service, such insulators are remarkably resistant to the passage of disruptive discharges, the puncture strength being from 15 to 35 per cent higher than that of porcelain insulators. Because of their transparency, they transmit sunlight to such an extent that their temperature rises but little above that of the surrounding air; and their low expansibility protects them from fractures when they are suddenly cooled by summer hailstorms or through other causes. Pyrex insulators will be used by the Government on TVA power lines. The qualities of these insulators for radio service are such that more than 300 broadcasting stations now employ them.

In an article of this length it is impossible to more than scratch the surface of the ramified activities of the Corning Glass Works. Four plants are operated, and in them are regularly produced thousands of kinds and sizes of glassware. It is significant, showing as it does the trend towards a wider utilization of glass, that in excess of 4,500 of the articles made there are designed exclusively for industrial services.

In our October, 1929, issue we presented the absorbing story of the activities at Wellsboro, Pa., where electric-light bulbs are turned out by ingenious machinery with almost unbelievable rapidity. The latest of the company's factories is a tube plant, at Corning, where machine methods have likewise been applied to a branch of glass-working that was formerly done entirely by hand. From a continuous-type, gas-fired melting tank, glass issues over revolving mandrels to be drawn and elongated into small-diameter tubing, the pulling impulse originating in machines located 150 feet away. These lines move for months at a time without a break in the fascinating monotony with which mile upon mile of glistening glass is formed, cooled, and cut into suitable lengths for handling. It is automatically graded as to size, after which it is either packed for shipment or transported to nearby machines which convert it into small light bulbs such as are used in automobile headlights, in flashlights, etc. Much of this tubing is also finding ready application in the manufacture of the popular neon-electric display signs.

Glass has been coming to the fore in recent years as an architectural material, and Corning has been a leader in this field. Under the name of "Steuben" architectural cast glass, it is being supplied for both interior and exterior decorative purposes. Such glass can be furnished in almost any color, texture, character, or shape, and architects have learned that it is no longer necessary to send to Europe for special designs. It is ordinarily employed to secure lighting effects, for heating and ventilating grilles, and for panels, but lends itself to a variety of other uses as well. It is heat-resisting and weatherproof. Attractive effects may be obtained with standard shapes, but, where desired, complete designs are furnished to fit in the general architectural scheme of a particular structure. In such cases, full-size models of a





AIR FOR STARTING ENGINES

Power for starting the gas-engine-driven compressor and the gas-engine generator set is supplied by the Class ER-2 compressor pictured above. It discharges at 250 pounds pressure into the eight storage flasks at the left. The upright cylinder at the left end of the flasks is a Maxim silencer which dampens the noise of the exhaust from the two gas-engine units.

plastic material are first made from the architect's drawings, and these are then used to construct metal molds for the casting of the glass. Decorative glass of this sort is found not only in buildings but also on many of the newer ships.

Among the recent interesting products to come from the Corning research laboratories is "Aklo" plate glass, which is capable of absorbing heat from the sun's rays. It is expected that it will be of great practical value for window use in connection with air-conditioning systems as an aid in maintaining summer temperatures at a comfortable level. Sunlight consists of three classes of rays: ordinary visible white light, invisible ultra-violet rays, and invisible infra-red rays. Collectively, these rays carry to the earth a volume of heat which, in New York State, for instance, may reach 300 Btu's an hour for every square foot of surface. Approximately 50 per cent of the heat energy is conveyed by the infra-red rays, and it is these which the new glass absorbs. This heat is subsequently given off by the glass, and as it is radiated from both sides some of it will pass inward. To obviate this it is proposed to construct double windows, using inside panes of ordinary glass that will prevent the penetration of the heat in the form in which it is given off by the outer glass. Experiments indicate that "Aklo" glass will be a boon to residents of the tropics.

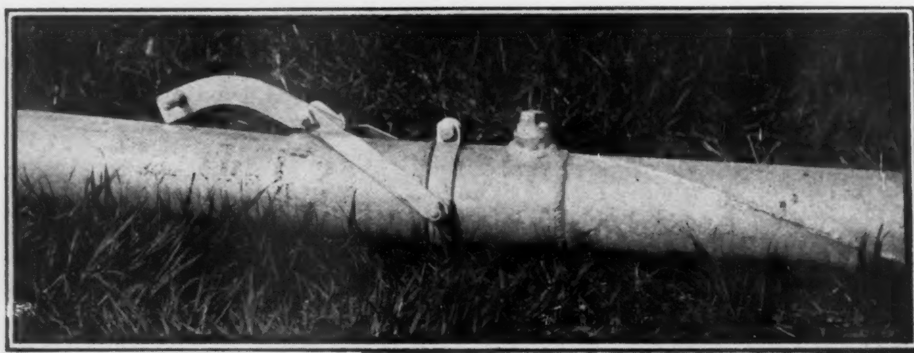
Another new development which holds great possibilities is the successful soldering of glass tops to ordinary tin cans. One of the large-scale manufacturers of cans is now testing the effect of the new product on the sale of various kinds of foodstuffs which are ordinarily offered the public in cans. If the results are satisfactory, the housewife may soon be able to inspect canned fruits, vegetables, meats, and other commodities before she buys them. It is also expected that such cans would enable buyers of paints to match colors with exactness.

It can be readily realized that the making of glass on such a large and diversified scale calls for a vast array of mechanical equipment and for the provision and maintenance of extensive facilities for furnishing and using power and fuel. In the main plant alone there are required each day 30,000 kw. of electrical energy, 7,000,000 cubic feet of gas, 1,000,000 gallons of water, and 7,500,000 cubic feet of compressed air.

Oil and producer gas formerly served as fuel for melting and for keeping in a molten state until used the huge tonnage of glass which is turned out daily. With the development of the Tioga, Pa., field, however, natural gas became available and is now employed exclusively. It serves not only as a source of heat but also as a means of generating electrical power and of producing a measure of the compressed air. For the former purpose, there has been installed recently an Ingersoll-Rand 1,200-hp., 6-cylinder gas engine which drives a General-Electric 800-kw., 2,300-volt, 60-cycle generator.

Compressed air is used at five different pressures—25, 40, 80, 100, and 250 pounds, depending upon its application. The three lower pressures are needed in the glass processing work, as an aid in gas combustion, for operating pressing machinery, and for cooling plungers, molds, etc.; the 100-pound air for maintenance and construction purposes; and the 250-pound air is utilized for starting the gas-engine units. Seven Ingersoll-Rand stationary compressors and two portables supply the air. The most recent unit installed is a Type XVG gas-engine-driven machine, which is illustrated. It consists of three V-type, 2-cylinder gas engines direct connected through a common crankshaft to three single-stage compressing cylinders. This new machine occupies less floor space than conventional units of the same capacity, and possesses numerous operating and maintenance advantages.

Most of the water supply comes from three wells. Two of these are 60 feet deep and the third is 80 feet deep. Pumping is done by means of three Cameron "Motorpumps."



AIR LINE AND COUPLING
On a major construction project in a mountainous region of California, showing (right) a section of a long air line made up of the new 4-inch-diameter, light-weight, spiral piping. At the top is a close-up of the improved coupling in closed position.

Special Piping for Long Air Lines

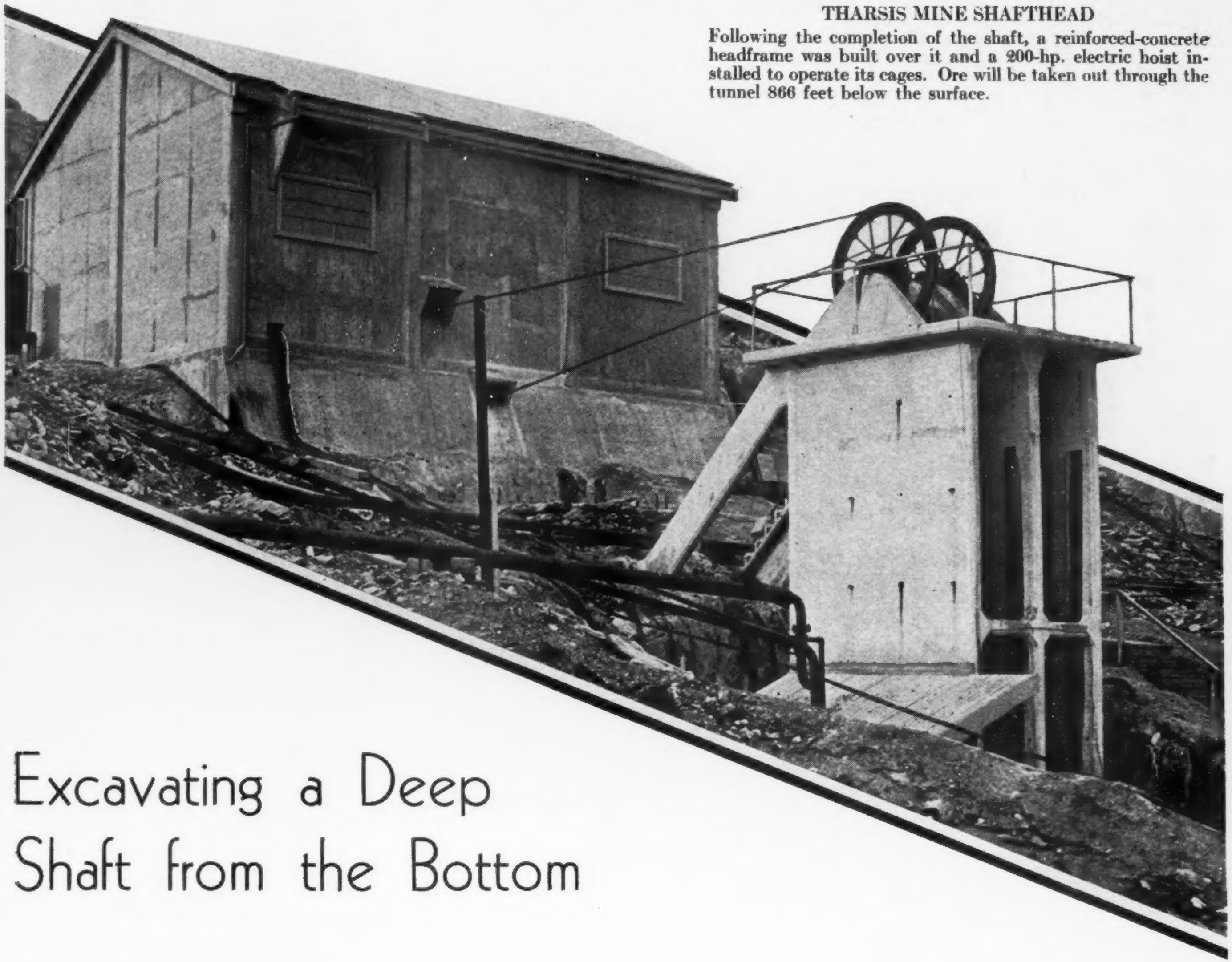
THE transmission of compressed air through long pipe lines, such as are frequently required on large engineering undertakings, has been made the subject of study by the California Highway Commission with the result that the Construction Department, in coöperation with the Equipment Department, has developed a light-weight, large-diameter pipe and an improved type of coupling which are now being used on all state projects involving much rock drilling. Some 7,200 lineal feet are now in service in local labor camps and elsewhere where numerous portables are on the job and where pipe lines several thousand feet in length are needed to deliver air to drills and other pneumatic tools and equipment.

"The transmission of compressed air through long pipe lines," says the *California Highway and Public Works* in a discussion of the investigational work, "causes considerable drop in pressure due to frictional loss, especially if the pipe is of small diameter. For instance, a compressor of 400 cfm. capacity and a pressure of 110 pounds at the receiver, using three rock drills and the usual air-hose connections on a 2-inch, 3,000-foot, wrought-iron pipe, gives a working pressure of about 61 pounds at the drills. This results in very low drilling speed, a pressure of 85 pounds being most efficient. If this size is increased to 2½ inches, drill pressure would rise to 92 pounds; 3-inch pipe would give 102 pounds; and 4-inch pipe, 108 pounds." It might be added here that compressor manufacturers have prepared tables by means of which it is possible to determine quickly the diameter of piping that should be used with any portable or group of portables so as to assure the most effective pressure at the drilling end of the line.

"The average 310-cfm. portable compressor," continues the *California Highway and Public Works*, "has a volumetric efficiency of about 70 per cent, which means that it will deliver about 215 cfm. at 90 pounds pressure. A 360-cfm. machine will deliver about 250 cubic feet, and a 310 two-stage, or one with a supercharger, will deliver the same quantity. Altitude decreases this volume about 1½ per cent for each 1,000 feet. Portable compressors of 450 cfm. are now available; and where there is a large amount of drilling to be done it is not unusual to hook up two 310-cfm. machines and to regulate them by one unloader. Therefore, the need of a large-size pipe line becomes apparent."

The piping as developed by the Construction Department is 4 inches in diameter and was first tried with satisfactory results in 1933 at the Kings River convict camp in the mountainous region of Fresno County. It is a spiral, welded, galvanized pipe made up of 20-foot lengths each weighing about 75 pounds, including connections. This is a considerable reduction in weight, inasmuch as wrought-iron pipe of equal proportions weighs 216 pounds, a 3-inch-diameter section weighs 151 pounds, and 2-inch pipe such as is often utilized, 73 pounds. Its comparative lightness is of advantage both in the matter of handling and assembling the separate units—the latter operation being further speeded up by the Venturi coupling and special locking device. For the purpose of connecting smaller air lines the pipe has 1- and 2-inch taps; and simple rubber gaskets effect airtightness. The line is said to withstand safely a working pressure of 230 pounds per square inch.

The use of the new large-diameter compressed-air pipe line, according to the organ of the California Highway Commission, is marked by an increase in drilling efficiency, aside from the facility with which it can be carried over uneven ground and up and down hillsides. Because of its size it acts somewhat in the nature of a storage tank or air receiver, and therefore permits more extensive manifolding than would otherwise be the case and also results in much steadier working of the drills. Piping of the kind in question has been in regular service now for about a year and a half, and to what extent it meets requirements and gives satisfaction has been expressed by the officials of the department in the following words: "We feel justified in saying that we would not undertake any extensive drilling operations without using the large-diameter, light-weight pipe."

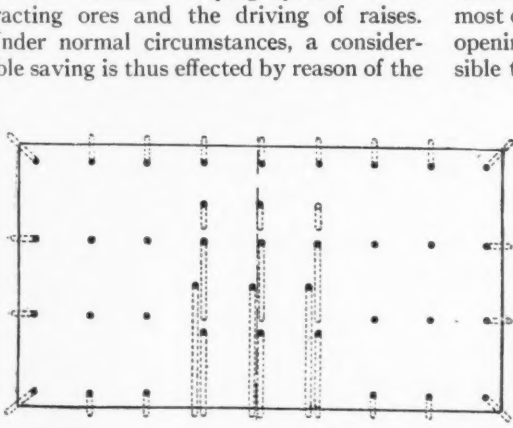


THARSIS MINE SHAFTHEAD
Following the completion of the shaft, a reinforced-concrete headframe was built over it and a 200-hp. electric hoist installed to operate its cages. Ore will be taken out through the tunnel 866 feet below the surface.

Excavating a Deep Shaft from the Bottom

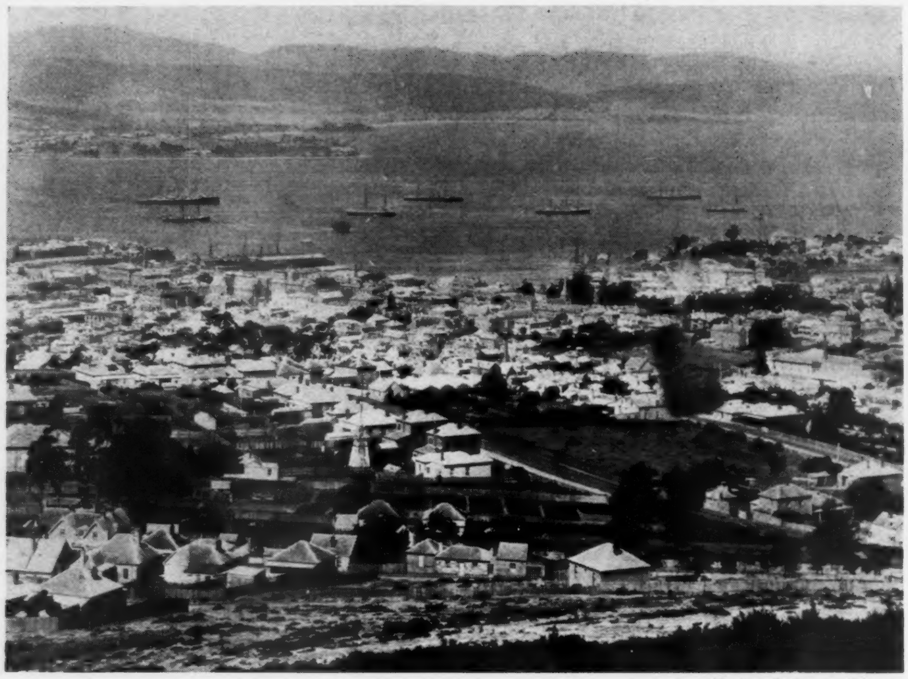
IT IS admittedly a very unusual procedure to dig a deep hole from the bottom upward: yet this has been done at the Royal Tharsis Mine at Mount Lyell, Tasmania. The operation in point was the rising of a vertical shaft a distance of 866 feet. It is customary in mining practice, wherever conditions permit it, to excavate from the bottom rather than from the top because it is usually more advantageous to do so. Familiar examples of this method are the overhand stoping system of extracting ores and the driving of raises. Under normal circumstances, a considerable saving is thus effected by reason of the obvious fact that the excavated materials can be disposed of by gravity instead of having to be hoisted. Thus the principle of overhead excavating is well established and entirely orthodox. Nevertheless, there is no available record of it ever having been followed previously on such an extensive scale, and the construction of the Royal Tharsis Shaft may, accordingly, be considered unique.

It is generally necessary to sink a shaft rather than to rise it because the shaft in most cases constitutes the initial or pioneer opening. In other words, it is seldom possible to start at the bottom because access to the bottom is infrequently to be had. In the instance under consideration it so happened that conditions permitted excavating from either top or bottom; and a preliminary study of the economic factors involved favored rising instead of sinking. More important to the practical mining man than the mere fact that common practice was reversed is the satisfactory result that was obtained. On this point we quote G. F. Jakins, mine superintendent for the Mount Lyell Mining & Railway Company, Ltd., who directed the work. "The project proved successful in every way," reports Mr. Jakins, "and the total cost of the completed shaft was much less than it would have been had the usual methods been adopted. An important point is that the use of the method is apparently independent of the height to be attained, as in this instance there would have been no difficulty in continuing the shaft to a much greater distance, had it been necessary."



DRILLING ROUND
A standard round consisted of 39 holes, fifteen in the central drag cut, which was blasted first, and twelve in each end cut. Water for the two stoper drills was pumped from below, the head reaching 1,100 feet during the final stages of the work. All blasting was done with fuses, using 50 per cent gelignite and No. 7 detonators.

The Mount Lyell Mining & Railway Company, Ltd., has for many years been one of the leading exploiters of the mineral wealth of Tasmania, and is generally



Ewing Galloway Photo

HOBART AND ITS HARBOR

Hobart is the principal city of the island, with a population of about 60,000. Tasmania is a new country, having been known to white men only since 1642. Its discoverer, the Dutch navigator Abel Janszoon Tasman, called it Van Diemen's Land, in honor of his patron. In 1853 the name now applied to it was adopted.

credited with having been primarily responsible for the rise of the island's copper-mining industry. Its Royal Tharsis Mine is a low-grade copper property situated in the western foothills of Mount Lyell. It was originally worked some 30 years ago by quarrying the surface outcrop, and was explored to a depth of 200 feet. The ore was used as a flux in the pyritic smelting process, and when it was no longer required for that purpose its production became unprofitable and the mine was abandoned. Subsequently, however, a tunnel, known as the North Lyell, was driven 7,000 feet to connect the treatment plant of the company with the 1,100-foot level of the North Lyell Mine. At a point about 5,000 feet in from the portal, this tunnel passes almost directly beneath the old workings of the Royal Tharsis and at a level 866 feet below the surface. From this opening the ore body was located by means of drifts and diamond-drill holes, its limits defined, and its values determined. The dimensions and assays thus obtained conformed with those at or near the surface, thus indicating that the deposit was uniform between the two levels. The ore body is a lenticular mass of copper-bearing schist which contains 2¼ per cent copper and 0.02 ounce of gold to the ton. It is 500 feet long and ranges from 70 to 100 feet in width. It dips or slopes at an angle of about 60 degrees.

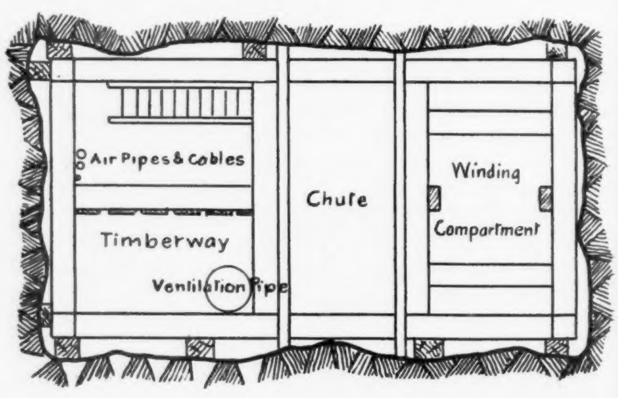
Because of the better facilities for working the deposit that were afforded through the completion of the North Lyell Tunnel in 1928 and of the advances in metallurgical practice that had been registered since the Royal Tharsis abandonment, it was believed that the property might be profitably exploited. Accordingly, the ore body was fully opened up at the tunnel level, and stoping of the cut-and-fill type was begun. This was a desirable scheme of mining, inasmuch as it obviated the need of hoisting ore and, also, of pumping water. It was apparent, however, that in order to open levels in the overlying ground, to transport men and materials to the higher workings, and to secure adequate ventilation of the mine, a shaft connecting the tunnel level with the surface would have to be provided. This having been determined, it remained only to decide whether it would be better to sink the shaft from the surface or to rise it from the tunnel. A study of this question pointed to the following advantages to be gained by the latter procedure: it would eliminate the necessity of building a surface plant in a locality remote from the base of operations; it would make for convenience of supervision as well as in supplying compressed air, water, electric power, and ventilation from the North Lyell Mine by way of the tunnel; hoisting of spoil and pumping of water would be unnecessary; spoil could be used for filling stopes at the tunnel level, thereby aiding maintenance operations there while the shaft work was in progress; and various levels above the tunnel could be opened up, in the order desired, as the shaft was being extended upward. The ultimate effect of all this, it was reasoned, would be faster progress and lower cost than could be obtained by sinking. The possible difficulties of excavating from below were expected to be: raising men and materials to the working face; providing adequate ventilation; protecting timbering in the completed portion from damage by spoil; and coping with any wet or unstable ground that might be encountered. Of the two, the rising method had so many more advantages to offer that it was definitely selected, and details of design and construction were determined accordingly.

The dimensions of the shaft were fixed at 15x8 feet and provided for two cage compartments, each 6½x3 feet, and one pipe, cable, and ladder compartment measuring 6½x5 feet 2 inches. It was decided to use 8x8-inch hardwood for timber and to place it in floors or courses 7 feet high. Each floor consisted of three rows of four legs each, and on top of these vertical members were laid two long caps or wall plates, running longitudinally across the two outside rows of legs, and four cross members—two end plates and two dividers. The plans called for levels at 120-foot intervals, or five between the tunnel and the lowest adit of the old workings that was 146 feet below the surface.

The entire undertaking was completed

PLAN OF SHAFT

The spoil chute in the center was braced on its two boarded sides by timber struts. In the ladderway (left), 1-inch boards arranged vertically were nailed to these struts, dividing the space into two sections. One of these held the ladder, air and water pipes, and cables: the other was used for hoisting timbers and also contained the ventilation pipe—a 15-inch sheet-iron tube through which as much as 2,000 cfm. of air was exhausted. Its upper end was kept within 100 feet of the working face. Drillers were able to return to work within 30 minutes after blasts.



in 71 weeks, or at the average rate of more than 12 feet a week. Its cost was £9,319, or the equivalent of $45,290 at the normal rate of exchange. The cost per foot was approximately $52. This figure takes no account of the value of the spoil as stope-filling material. A noteworthy feature was the small labor force required. Only two men to a shift worked at the face. For the first 36 feet they were paid wages, but after they had thus gained experience they undertook the work on contract. Their payment on this latter basis ranged between $19.50 and $24.30 a foot, and it is significant that for the uppermost 231 feet of the shaft the contract price was less than $22 a foot, or considerably under the maximum. The men operated in three shifts, each group working eleven shifts per fortnight. In addition to the contractors, two special timbermen were employed. They did not work continuously in the shaft, but were subject to call whenever it was ready for timber. Besides wages, they were paid a bonus of $2.50 for each 7-foot floor of timber erected. A hoist operator on each shift, and two trammers on one shift to dispose of spoil completed the working force.

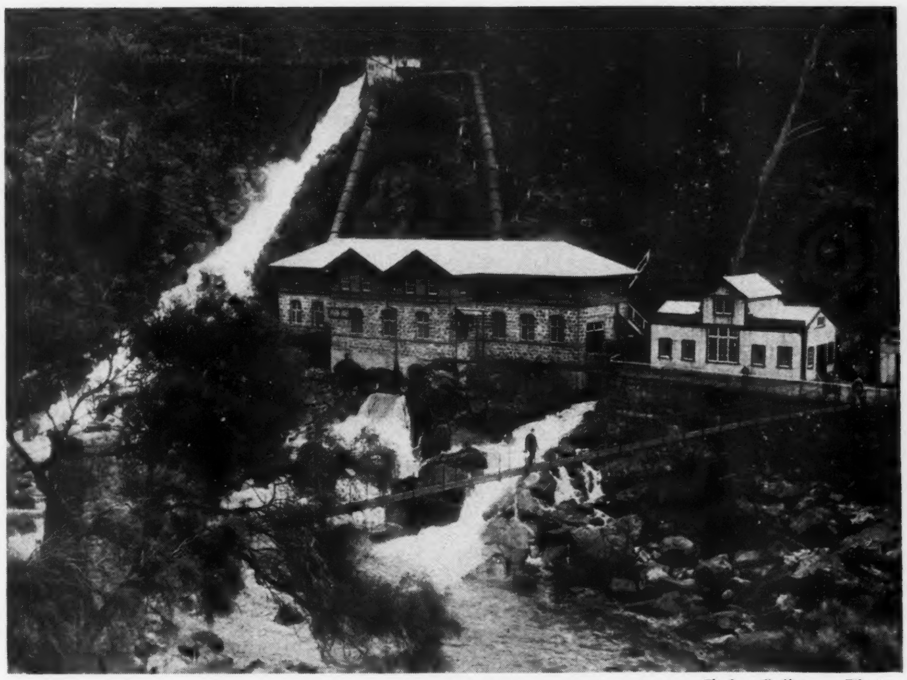
The material penetrated by the shaft was moderately hard schist. This stood well except at one place, 450 feet above the bottom, where a heavy flow of water transformed the rock into a clayey mass. Until this section had been passed, the timber was kept close to the roof.

The shaft was started at a point 80 feet from the tunnel on a prospecting drift from where the opening, it was believed, would clear the northern edge of the ore body throughout its course. The shaft was first cut out full section on one side of the drift and excavated to a height of 20 feet. An opening-out set of timbers, 13 feet high, was then erected, as shown in an accompanying drawing. The center compartment was lined with boards to form a spoil chute, and this was fitted with a door for loading side-dump mine cars of 1-cubic-yard capacity. The cage compartment at one end was left open, and the ladderway compartment at the other end was selected for the installation, besides the ladders, of a 2-inch air line, a 1-inch water line, a 15-inch ventilation pipe, and telephone, light, and signal cables.

Sawed timbers of 8x8-inch section were laid on top of the opening-out set, forming a platform that was continuous save for an 18-inch-wide opening directly over the chute. This aperture was provided for the disposing of blasted material and also gave access to the platform from the ladderway, the top 2 feet of chute lining being left off on the ladderway side.

The first of the series of blast-hole rounds by which the shaft was progressively carried upward was then put in. Two stoper drills, using air at 85-90 pounds pressure and fitted with 7/8-inch drill steel, were utilized throughout. A transverse cut was first made in the center and blasted, after which the sections on either side of it were shot. Details of the drilling round are shown in an accompanying sketch. The main holes were drilled 7 feet deep. The progress per round was about 6 feet, four rounds usually being required to permit the placing of three floors of timbers each 7 feet high.

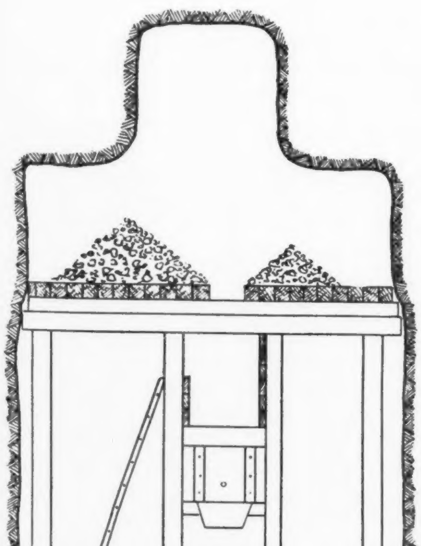
After firing the final holes, the two drillers returned to the platform, barred down any loose rock from the walls or roof, and, whenever sufficient overhead clearance was available, made ready for the installation of another course of timber. Before all the spoil was removed, a stull was wedged across the shaft over the center of the ladderway and near the roof, and a pulley block and chain suspended from it for use in hoisting timbers. For this purpose, a 1-ton compressed-air hoist was mounted on a column situated on the tunnel level below and in a chamber on the opposite



Ewing Galloway Photo

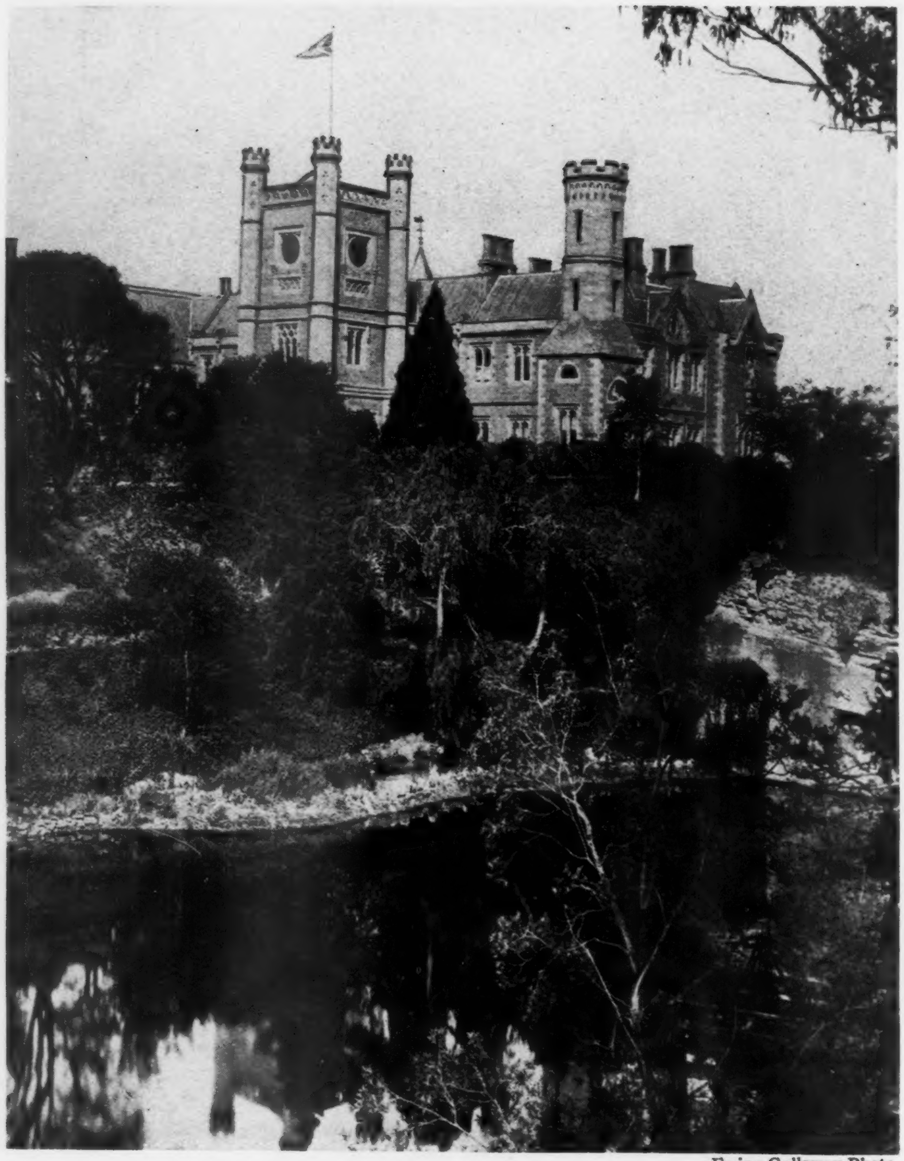
MOUNTAIN POWER HOUSE

Although it is only about as large as West Virginia, Tasmania has varied natural resources. Its mountains reach to extreme altitudes of more than 5,000 feet, and from these higher sections issue streams of great potential power development. The hydro-electric generating station shown here is near Launceston, in the northern part of the island. The western half of Tasmania, which remained unexplored for a long time, proved rich in minerals. The Mount Bischoff Mine, opened in 1871, has been a great tin producer, having paid several million pounds sterling in dividends. Tasmania now produces gold, silver, tin, copper, coal, and other minerals.



GENERAL EXCAVATION SCHEME

After the shaft had been carried upward 20 feet, an opening-out set of timber was installed and floored over as shown. This set had a central muck chute with a door from which to load cars. Drilling was done with stopers, a central cut being first made, as illustrated, and the ends then shot. The spoil was shoveled into the chute through an opening left in the platform. Above the opening-out set, timber was erected in 7-foot courses or floors. Levels were cut at intervals of 120 feet, and at each of these a collar set was placed and another opening-out set installed.



Ewing Galloway Photo

THE GRAY HOUSE

The government of Tasmania is centered in this building at Hobart. Tasmania formerly was used as a penal colony by the British, and a large proportion of its population was convicts. This practice ceased in 1853, and in 1856 representative government was established.

side of the drift from the shaft. The rope from this hoist was led through a pulley at the foot of the ladderway, thence up the ladderway, and around the suspended pulley.

When the spoil had been cleared from the platform, the lagging was removed to expose the mortised openings in the top of the opening-out set of timber, and the members for the following set were then hoisted and placed by the timbermen. The eight wall legs were erected first, and the long caps adjusted, after which the remaining four legs and the cross members were installed. The hoist elevated the eighteen pieces of timber in six trips; and, although the long caps weighed about 450 pounds each, the men became so experienced in maneuvering the various members into position that little lifting on their part was required. The timbers were all dressed at the company sawmill. Each floor set was assembled there and the pieces numbered so that they might be erected in the shaft exactly as planned by the mill carpenter.

After the floor timbers had been placed, the platform lagging was hoisted, four pieces at a time, to the top of the section and relaid. The drills were next hoisted to the new position, and the miners resumed drilling while the timbermen plumbed and blocked the set. About four hours' drilling time was lost whenever a floor was placed, and the timbermen were engaged an average of eight hours during which they lined the spoil chute and equipped the ladderway to the higher level.

The chute was lined on the two sides adjacent to the end compartments, 8x3-inch hardwood boards being laid horizontally. The other two sides along the shaft walls were left unlined to prevent the possible bursting of the compartment under air pressure in the event of its clogging with spoil and the accumulation then suddenly giving way with a rush. The long caps which were exposed were protected by fitting over them shoes made of 3/8-inch steel. The level of spoil in the chute was kept within 20 feet of the top so that those protruding members might not be subjected to the shock of heavy rocks falling from great heights. On its two boarded sides the chute was braced with struts placed across the end compartments. Those in the ladderway were located in the center at 7-foot intervals, and to them 1-inch boards were nailed vertically, thereby dividing the compartment into two sections. One of these contained the ventilation pipe and was used for timber hoisting, while the other served the purposes previously mentioned. Two vertical rows of bracing struts were placed in the compartment at the other end and were so disposed as to give clearance for a small cage which was operated there. A compressed-air whistle was mounted in the ladderway as a means of signaling the men at the face whenever anyone wished to ascend.

The shaft was carried upward in the manner described to a height of fifteen floors, or 120 feet above the opening-out set, where the first of the new levels was to be cut. There a plat or chamber, 15 feet wide, 16 feet long, and having a roof sloping from a height of 13 feet at the shaft to 10 feet at the back, was blasted out at one side. Hitches were then cut in the rock to receive the ends of the collar set which was to support the next 120 feet of timber. This collar set was jointed to the legs of the preceding course, from which the long caps and cross members were removed for use at a higher elevation.

Work on the second level-section began by excavating the shaft to a height of 20 feet and then installing an opening-out set similar to that on the lower level. This was divided into compartments as before, and the spoil chute was equipped with a door through which the material could be directed into the chute below by means of a slide which was channeled through the floor of the plat. The shaft was next raised another floor, after which work was started on the installation of the cage in the winding or hoisting compartment at one end. This cage was designed for the transportation of men and materials between No. 7 and No. 6 levels. Before this was done, the 1-ton air hoist was moved to the higher level by its own power. The rope was wound up until the hook at its loose end reached the pulley suspended at the face, where it fouled; the column on which the hoist was mounted was freed; and the hoist shifted to one end of it. Two 60-foot air hoses, which conveyed air to the drills, were then coupled together and connected to the hoist and to the air main at the lower level. After the air was turned on, the hoist began to wind itself upward, the hose being paid out to follow it. The hoist, with the column attached, was landed at the level above and there set up to serve during the

succeeding lift of 120 feet as it had done on the first lift. At this stage, No. 6 Level was electrically lighted and equipped with a telephone and signal service for communication during the hoist operation.

With the air hoist again installed, the cable from the main hoisting engine was pulled up the winding compartment, passed over a sheave mounted on top of the opening-out set, and drawn down the shaft to the lower level, where it was secured to a cage capable of holding four men. The main-hoist mechanism was an 8x10-inch, double-drum, air-driven unit. One drum carried 1,650 feet of $\frac{15}{16}$-inch rope and the other a shorter length of rope that was used as will be described presently. After four courses of timbers, or 28 feet, had been erected, the uppermost sheave was moved to the top of the third course to provide more headroom for hoisting. The manner of doing this is described by Mr. Jakins as follows:

"The spare rope carried on the second drum of the main hoist was pulled to the cage on No. 7 level and shackled to the thimble on the hoisting rope. The cage was then raised to No. 6 level and landed, when the hoisting rope was unshackled from the cage. The spare rope was then used to pull the end of the hoisting rope back to No. 7 level. The portion of the hoisting rope from the hoist up to No. 6 level was clipped at this level and fastened to the shaft timbers. Then the two ropes were unshackled and the free end of the hoisting rope was pulled over the sheave and coiled on No. 6 level.

"The 1-ton hoist was then used to lift the sheave and its fittings to their new position. This was done by placing two pulley stulls, one over the ladderway and the other over the winding compartment. After pulleys had been hung to these stulls, the rope was led from the hoist up the ladderway, along the length of the shaft, and down the winding compartment to the sheave. When the latter had been lifted and secured, the hoisting rope was drawn over it and lowered to No. 7 level, where it was again shackled to the spare rope. The hoisting rope was unclipped at No. 6 level and the end hauled back to the cage, to which it was again attached. The last stage was to lower the cage and spare rope to No. 7 level, and wind the latter rope back on its drum.

"When shifting the sheave to higher levels, the two shackled ropes were drawn back only to the level immediately below, and the spare rope hooked on to the shaft timber there while the hoisting rope was being lifted by the small hoist and secured so that it could be placed on the sheave. The spare rope was then similarly raised and shackled to the hoisting rope. This course obviated handling a long length of rope on the plat above."

As the shaft progressed upward toward the surface, the cage was placed in operation to each new level soon after it was opened. Accordingly, the only climbing required of the workmen was in the section under construction. Timber for each floor was hoisted by cage to the nearest level. Supplies of steel and explosives were requisitioned by telephone and likewise delivered to the plat immediately below the face. As a result of this method of handling, the final section from No. 1 Level to the surface was completed with almost the same ease and dispatch as was the first section.

In order to use as much of the spoil as possible in replacing extracted ore, a raise was driven to connect No. 7 Stope with No. 6 Level, and from the top of it a drift was run to No. 6 Plat. Thereafter, all material coming down the chute was trammed on No. 6 Level and distributed to the workings below, instead of being hauled out of the North Lyell Tunnel for disposal. This made it possible to mine 40,000 tons of ore while shaft-rising was underway. After the shaft had reached the surface, considerable development work was done on levels Nos. 4, 3, 2, and 1, and the shaft chute was employed to handle spoil. The shaft was then equipped for permanent use. It was found that the shaft timbers had not been damaged, despite the fact that rocks weighing up to a ton were often sent down the chute. This was attributed to the plan in force, under which the sections of the chute between the various levels were kept substantially full, spoil being drawn down successively from top to bottom as the trammers required it. The entire work was done without any workman incurring a serious injury.

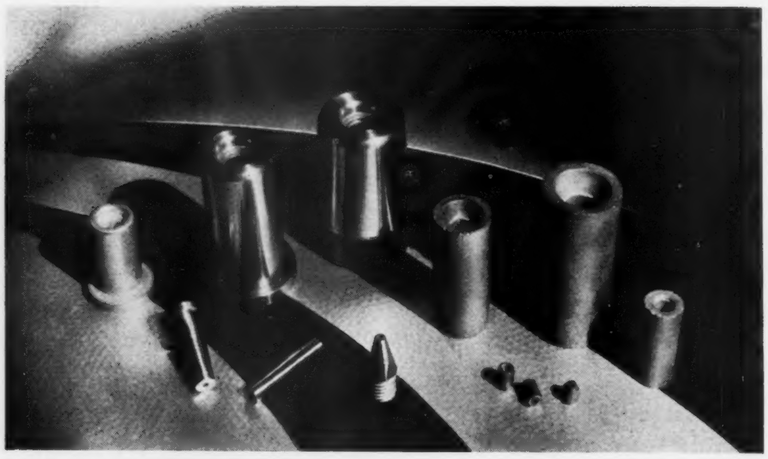
Ewing Galloway Photo

RUSSELL FALLS

Tasmania abounds in picturesque scenery, and in the non-mountainous sections the soil is very fertile. Of late years, the island has become an important fruit producer. The climate is temperate. Tree ferns, which are plentiful in the upland ravines, are shown in this view from the National State Park.

For the facts in the foregoing account and for the quotations included in it, acknowledgment is made to Mr. Jakins and to his paper, *Rising the Royal Tharsis Shaft at Mount Lyell, Tasmania*, which was read before the Australasian Institute of Mining and Metallurgy.

Norbide---
a Real Rival of the Diamond



SAND-BLAST NOZZLES AND LINERS

It is reported that the use of Norbide liners will increase the service life of sand-blast nozzles hundreds or even thousands of times, decrease the air consumption, and improve the over-all efficiency of the apparatus. The manufacturer guarantees such liners for 750 hours of service when using silica-sand abrasive at not more than 90 pounds air pressure. In the picture, nozzles of various sizes are shown at the left and liners for them at the right.

ANCIENT man conjured up a dream stone which he imagined to be so hard that it would endure forever, and he called it adamant. The myth of its existence was soon dispelled; but modern scientists have succeeded in making a material that closely approaches it. It is boron carbide, the hardest artificial substance ever produced, and one that is exceeded among natural materials by the diamond only.

Boron carbide was developed by Norton Company of Worcester, Mass., and announced by Raymond R. Ridgway of its staff. It has been given the trade name Norbide, and is a combination of the rare metal boron and of ordinary carbon such as occurs in coke. It is unaffected by the strongest acids and alkalies, has a compressive strength of 260,000 pounds per square inch, a coefficient of expansion approximately two thirds that of steel, is little affected by temperatures up to 1,832° F.—at which point the diamond burns completely, and is lighter than aluminum.

In the making of the new carbide, the purest medicinal quality of boric acid is taken from the hottest place in the United States where humans live, Death Valley. Into Searles Lake, which is so loaded with crystallizing solids that it has a crust as strong as a layer of ice, holes are drilled, and the saturated brine solution containing boron is pumped up from the lake bed. The extracted boron is shipped to Niagara Falls, where high-temperature electric furnaces convert it into an abrasive.

"The process for converting a material which is mild enough to be used as an antiseptic for the eyes into the hardest-known synthetic material is simple enough when properly controlled," says Mr. Ridgway. "The first step involves the removal of the water of crystallization which accompanies the boric-acid crystals. The removal of this water changes the physical character of the smooth crystals into that of a hard glass slightly harder than ordinary window glass. This anhydrous oxide must be carefully protected to prevent it re-absorbing water from the air and returning to its normal form of boric acid. Carefully weighed quantities of the anhydrous glass are proportioned with the highest grade of petroleum coke, since the inclusion of any ash impurities will destroy the quality and value of the resultant abrasive. In a furnace, which reaches a temperature of approximately 5,000°F., the oxygen is taken from the glass and carbon substituted. At the very high temperature obtainable only in the electric furnace, the carbide melts, and from this melt crystallize beautiful crystals of boron carbide which may serve as an abrasive just as they are taken from the furnace.

"The new material has found an immediate use in the cutting and lapping of the new hard alloys known as cemented tungsten carbides which have replaced high-grade tool steel in many industries. It was not long ago that these carbides were offered as a tool material of such great synthetic hardness that it was difficult to shape them with the ordinary abrasives.

"Experiments have shown boron carbide to be useful for many previously unsuspected purposes. The art of pressure blasting has always been carried on in industry with metal nozzles to control the spray of sand or other abrasive directed against castings and metal surfaces of all kinds. The cleaning of public buildings, the preparation of metal surfaces of automobiles before painting, and the engraving of marble monuments has been carried out for years with the aid of pressure blasting or, as it is more commonly known, sand blasting. To a certain extent the application of hard abrasives to such cutting jobs has been impeded by the high rate of wear on the metal nozzle caused by the abrasive stream through it. The research laboratories of the Norton Company have found that this new carbide is very much harder than the hardest of the old abrasives and that it can be molded into pressure-blast nozzles having many thousand times the wear resistance under blasting conditions of any metal material previously used for this purpose. In some cases one nozzle will last the life of a sand-blast machine, where formerly a nozzle was completely destroyed in thirty minutes.

"Because of the high intrinsic hardness of the product, it was immediately tried on work for which gem materials have been necessary. In this field many successful uses have been discovered. For the drawing of fine wires of all kinds it has heretofore been economical to use large diamonds carefully drilled to produce wire of a definite size by drawing through the opening metal bars of a slightly larger size and by successively reducing the rods until they sometimes became so small that they were finer than the most delicate human hair. This application has been made of the new carbide, and its use has been extended in this field.

"Wear-resistant bearings of all kinds have been manufactured of the new product suitable for inclusion in such widely different apparatus as electric meters and high-speed rotating spindles on grinding machines. Here the high polish and hardness of the boron carbide approaches those obtainable with the highest-grade industrial diamonds. In a certain sense, therefore, we have in boron carbide the industrial diamond obtained by synthetic means.

"It thus appears that as soon as a need develops in industry for a new product, research laboratories set out to find it. The application by the research staff of the du Pont Company of a new means for delustering rayon led to great abrasive wear on the tiny guides that control rayon threads on textile machinery. The ordinary porcelain and even synthetic ruby guides used on weaving and spinning machines deteriorated so rapidly as to endanger the commercial feasibility of the process. The application of boron carbide to the guide surfaces has solved this problem."

The Magicians of Shawinigan Falls

W. M. GOODWIN

CANADA'S ELECTROCHEMICAL CENTER

The community of Shawinigan Falls, Quebec. In the foreground are power plants which can produce 339,000 hp. of energy. The cloud of white fumes near the top marks the site of the calcium-carbide plant of Shawinigan Chemicals Limited, and beneath it are the other buildings of this largest chemical concern in the British Empire. The plant of the Canadian Carborundum Company is also in this area. In the left and lower quarter of the picture are the establishments of the Aluminum Company of Canada and the Belgo pulp and paper mill. The upper view, from an engraving published in 1880 in *Picturesque Canada*, shows the falls as they once looked. The structure at the left is a log chute. Shawinigan Falls is on the St. Maurice River 24 miles above the point where the latter joins the St. Lawrence. The St. Maurice is 400 miles long and, with its tributaries, drains an area of 21,000 square miles.

AN OLD saying tells us that "you can't make a silk purse out of a sow's ear." Achievements much stranger than this, however, are now an everyday occurrence in the realm of modern science and industry. A pair of silk stockings, for instance, is made today from a chip or two of spruce wood, a pinch of salt, a little sulphur, a small lump of limestone, a thimbleful of coal, some air, and a little water, all combined in stages by means of a good deal of electrical energy. Each of these raw materials is required to play its part in the series of syntheses that results finally in the gossamerlike filaments that rival in appearance and usefulness those of the silkworm. And so abundant are the raw materials and so effective the machinery of man's devising that the silkworm, which simply has to chew up the mulberry leaves and let them pass through its body, cannot compete in cost with the complicated factory process of making silk.

This modern alchemy is employed in a wide variety of ways in one of Canada's principal electrochemical districts, Shawinigan Falls, Que. Thirty years ago this was simply a beauty spot in the midst of the unbroken wilderness. Today it is the center of the 1,000,000-hp. St. Maurice River hydro-electric development, a substantial part of the power of which is being converted within the boundaries of the town into many useful products. While much of the power goes out over the high-tension transmission lines that radiate from there to turn the wheels of industry at Montreal, Three Rivers, and a score of other communities, some of it is represented in the outgoing freight on the railways that is consigned to all parts of the world.

Each of the large electrometallurgical and electrochemical industries at Shawinigan Falls has a story that smacks of romance, but the present one will be confined to Shawinigan Chemicals—a "war baby" that has grown up into a robust and vigorous youth with promise of a rather remarkable maturity.

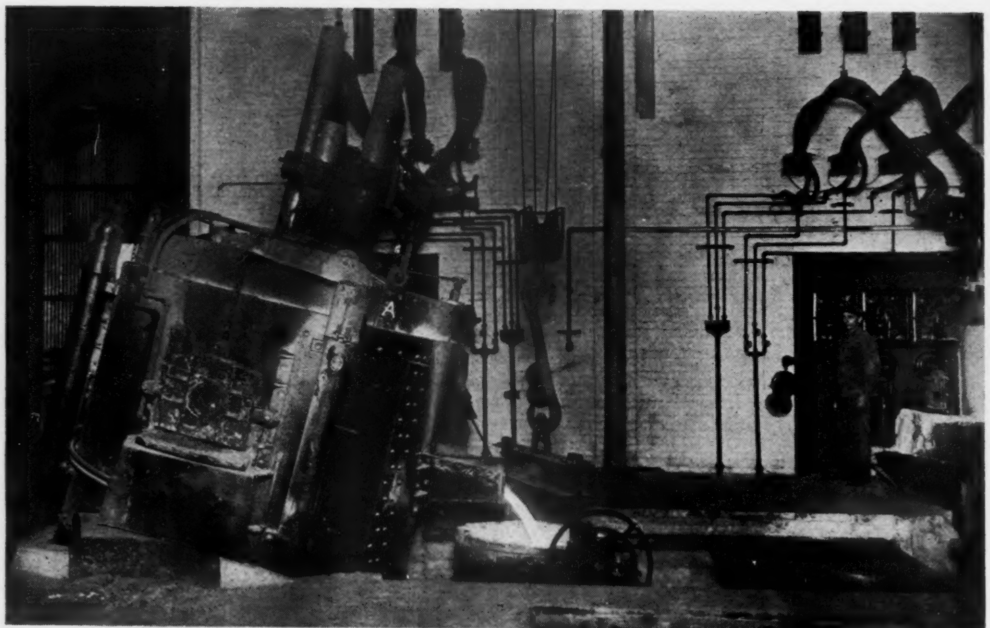
One of the early plants to be established at Shawinigan Falls was that of the Canada Carbide Company, whose product was utilized for making acetylene gas. The plant had a modest output, used largely for the old-fashioned acetylene lighting sets and for miners' lamps. It was in 1915 that the Imperial Munitions Board, faced with a serious shortage of acetone for the manufacture of military explosives, commissioned the Shawinigan company to put into practice certain German patents for making acetone from acetylene.

The patent papers specified a series of syntheses by which acetylene was to be converted into acetaldehyde, the latter into acetic acid, and this, in turn, into acetone; but they did not tell very much about how to effect these transformations without inviting the danger of an explosion. A staff of engineers and chemists set to work to find out; and so successful were they that within six months they had a practical process established on a laboratory scale, and within a year they were turning out acetone by the carload.

At the end of the war the demand for acetone all but vanished, so the management of Shawinigan Chemicals proceeded to create other markets for its products and

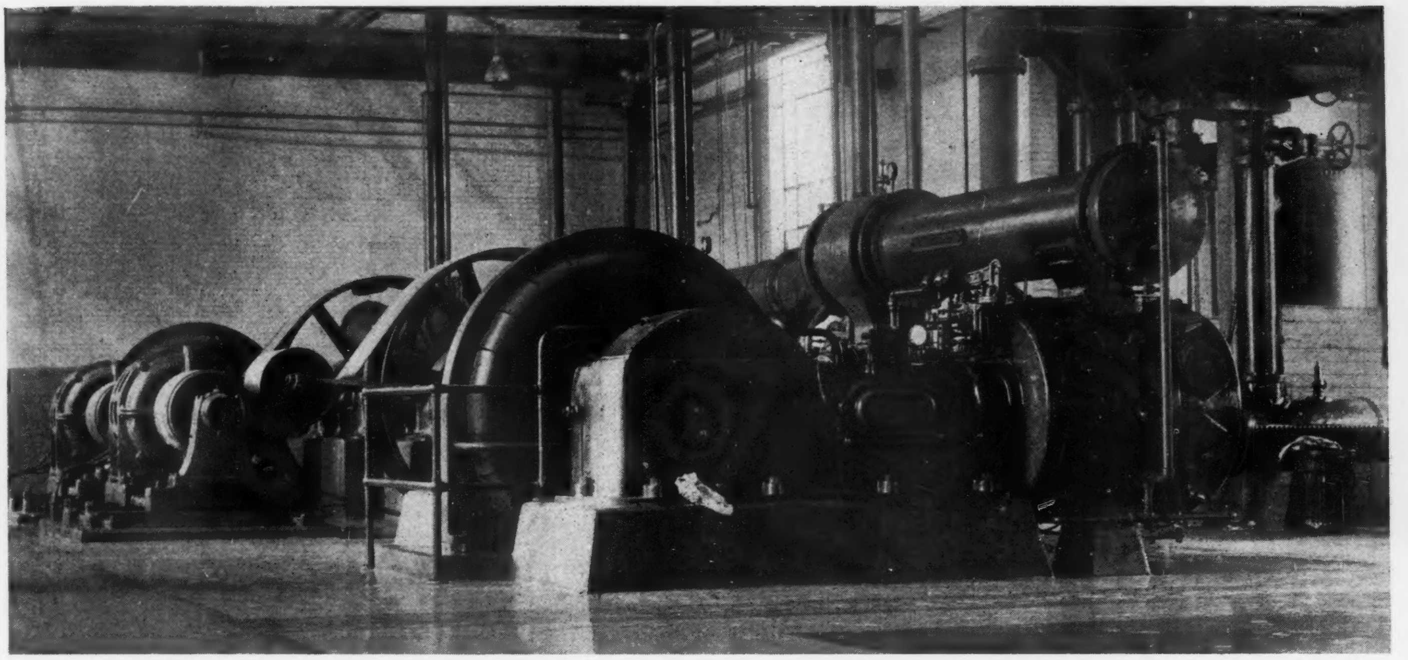
POURING DURIRON

A stainless and heat-resistant alloy steel results from combining iron and silicon in a high-temperature electric furnace. The one shown at the right is of 2 tons capacity. Shawinigan Chemicals Limited makes Duriron equipment for handling dilute sulphuric acid in its acetone process, and also sells castings for use in paper, pulp, and textile mills, chemical plants, explosive works, and for pumps and valves designed for the handling of corrosive mine waters, etc. In the center view, Duriron is being poured from a ladle into a mold. This alloy is amenable to shaping only by casting. Numerous pneumatic tools are employed in this foundry.



SHAWINIGAN CHEMICALS LIMITED

It is here that such commonplace substances as coal, wood, limestone, sulphur, iron, and air are transformed by modern alchemists into scores of useful products whose names are mostly unintelligible to the layman. The original plant made calcium carbide for acetylene lighting systems and miners' lamps. The war metamorphosed it almost over night into a huge acetone factory. Since the armistice, its research experts have been successful in finding peacetime uses for its wartime products and in improving its processes to the point where Shawinigan chemicals can compete with others in almost any part of the world.



AIR COMPRESSORS

In this room are four modern air compressors whose combined piston displacement is 7,436 cfm. The air is compressed to 100 pounds pressure, and is used in the chemical processes, in construction work, and for miscellaneous purposes. These machines, as well as the ammonia compressors in the plant, were built in Canada by the Canadian Ingersoll-Rand Company.

to discover what other useful materials it could make with acetylene gas as a base. This was no easy task, and at times it seemed hopeless. But the company's research men again persisted, and to such good effect that today the chemical plants at Shawinigan far exceed in capacity their wartime maximum. Now they turn out a variety of products that insures a fairly stable market, and the processes have been so improved that those products can meet competition almost anywhere.

Let us take a run through the different plants that have grown up around the original carbide plant within the past twenty years, noting particularly the raw materials and the output of each. It is in the carbide plant itself that the latent energy is stored up that is used to effect many of the subsequent transformations.

Calcium carbide is made by melting together calcined limestone and coke in the intense heat of an electric-arc furnace. The large amount of energy required for this can be gauged from the fact that 20,000 hp. is concentrated and expended in one furnace hearth about 20 feet across. The white-hot carbide is periodically tapped into molds, crushed, and sized for market. The fines and a part of the lumps are converted into acetylene in an adjoining plant for the company's own use.

In the acetylene-gas plant, the gas was formerly manufactured by adding carbide to an excess of water and flushing out the resultant slimy calcium hydrate with still more water. The wet hydrate, a useless product, is no longer made, a marketable substitute being provided instead. In the present process, just enough water is added to the carbide to make the dry hydrate of lime, some of which is briquetted and returned to the carbide furnaces while a part is taken out of the circuit and sold as "chemical lime hydrate" for use in various industries. Thus most of the lime now simply circulates, acting as a vehicle for bringing together carbon from the coke and hydrogen from the water to produce acetylene gas.

The acetylene gas is piped across to the chemical plants, where an amazing series of transformations is effected, the only other substances required being air and water, with an abundance of electrical power. Scores of different chemicals have been built up from acetylene in the laboratory, but only about a dozen are being made in commercial quantities at present.

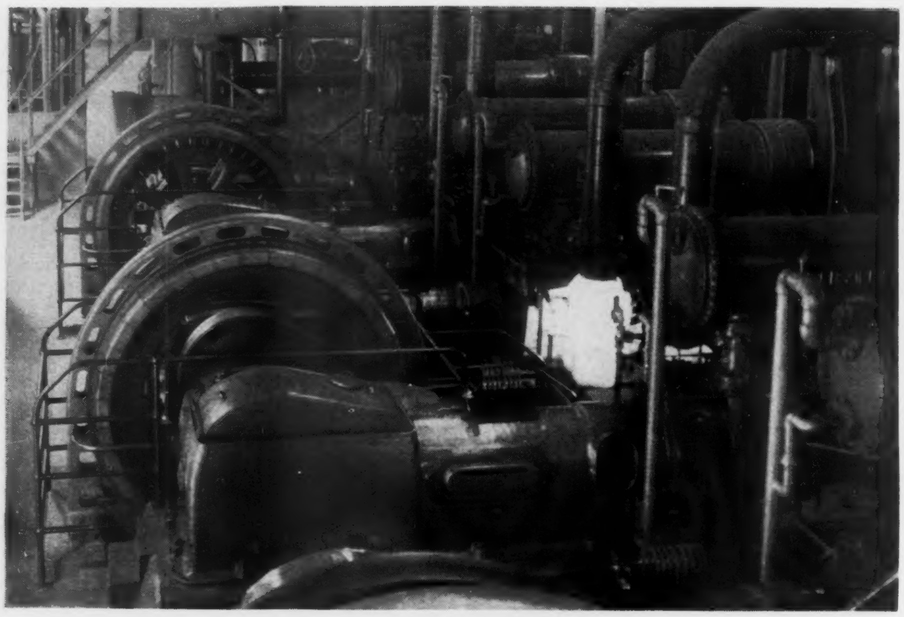
In the Hydration Building the gas is subjected to No. 1 Process, namely, a chemical combination with water. This is effected by passing the gas through hot, dilute sulphuric acid containing mercury salts which act as a catalyst in promoting the union of the gas and the water. This union gives acetaldehyde, a compound chiefly of interest because of its extraordinary chemical activity, which is employed to advantage in the subsequent reactions.

Hot, dilute sulphuric acid is one of the most corrosive liquids in commercial use, and the only known metal that can withstand it is the alloy of silicon and iron, "Duriron." The huge kettles and the various pipes and fittings containing this corrosive solution are, therefore, composed of this expensive alloy. The metal can be made only into castings, and some of these are of large size. This item illustrates the practical difficulties that had to be overcome in order to establish this process commercially.

Acetaldehyde is a colorless liquid with a low boiling point—it boils if held in the palm of the hand. To handle it conveniently, therefore, it must be cooled by refrigeration. As No. 1 Process and those that follow subsequently are exothermic, it is necessary to get rid of the heat thus generated. Consequently, a large refrigerating plant is required, one capable of producing 3,500 tons of ice a day. This is an incidental feature of the plant, but it indicates the scale on which it operates.

The liquid acetaldehyde is piped to the Oxidation Building where No. 2 Process changes it to acetic acid. This is done in a series of 1,000-gallon kettles by blowing air through the liquid under pressure, 30,000 cubic feet of free air per minute being so used. Acetaldehyde combines readily with the oxygen of the air, and the remaining nitrogen is discharged. At some time in the future it is likely that this large volume of pure nitrogen will be put to service. The acetic acid is simply the vinegar of household use in a pure and concentrated form. It has many fields of application, but at present the bulk of it is employed in the manufacture of artificial silk. Some goes to the Malay rubber plantations where the pure acid gives a superior quality of latex, compared with the product obtained by the former crude methods.

Not so long ago, No. 3 Building was devoted to the making of acetone from acetic acid—in fact, prior to the end of the World War the whole plant was given over to its production. The acid was heated and the



REFRIGERATION EQUIPMENT

One of the intermediate products in the making of acetone is acetaldehyde, a liquid which, because of its low boiling point, must be cooled for convenient handling. For this purpose there is installed machinery capable of producing 3,500 tons of refrigeration a day. It is considered to be one of the largest plants of its kind on the North American continent. Some of the ammonia compressors, which are the heart of the system, are shown here. Each of the three machines pictured can handle 3,386 cfm. of ammonia gas, and is driven by a 1,000-hp. synchronous motor.

vapor was passed over a catalyst consisting of a coating of hydrated lime on iron balls. This decomposed the acid, the result being liquid acetone with carbon dioxide and water as by-products. This process, while effective at the time, was wasteful because it turned more than half of the acid into the valueless water and carbon dioxide. Today, acetone is made by more economical methods, and No. 3 Building now houses a completely equipped machine shop capable of doing the large and heavy work required in the maintenance of much of the equipment. Here we have a clear case of "beating swords into ploughs and spears into pruning hooks."

No. 4 Building is the Still House, where the crude acetaldehyde and acetic acid are refined and where the numerous grades of the acid demanded by industry are prepared. This tall building is rather remarkable in appearance inside, resembling somewhat an indoor oil refinery with fractionating columns and stills of great variety. The entire space is surmounted by a traveling crane which can pick up any unit and replace it with the spare that is always ready.

Solvents are made in No. 5 Building, principally ethyl acetate. Two molecules of acetaldehyde are caused to unite by a special procedure to produce this useful solvent, which is employed largely in the manufacture of lacquers. Among the other solvents manufactured by the company at present are butyl acetate and amyl acetate.

No. 6 Process, the latest to be established at Shawinigan, is carried on in the Gelva plant. When acetylene gas combines with acetic acid there is formed vinyl acetate. This is the basic material for one of the most serviceable of the synthetic resins yet discovered. Vinyl acetate readily polymerizes or condenses to a clear, glasslike solid, and this material, as made by Shawinigan Chemicals, is called Gelva. A modification of Gelva, employing the ever-useful acetaldehyde in a further reaction, is known as Alvar; and if formaldehyde is substituted, a third resin, Formvar, results. These three resins can be made in a wide range of viscosities and softening points applicable to almost any of the uses to which resins may be put—such as varnish bases, molding powder, films, impregnating compounds, insulating materials, chewing gum, etc.

No. 7 is what might be called the plant's service building. It contains, for instance, three 1,000-ton refrigerating machines, three large air compressors, the pumps required for circulating the calcium-chloride brine used as a refrigerant, and the pumps for the substantial flow of cooling water drawn from the St. Maurice River and returned to it again—the equal of a good-sized brook. Electric-steam boilers using surplus power, which is a great deal cheaper than coal for making steam, is a feature of this plant.

There is another process that has recently attained considerable commercial importance and that is a convenience to the series of chemical plants described by reason of the fact that it consumes any excess of acetylene gas that may be available, thus acting as a balancer for the system. This is the Shawinigan Black Plant where, by very simple means, the carbon of the acetylene is liberated as carbon black of unique quality. The decomposition of the gas is quantitative, so there is no waste of gas as is otherwise the case. Shawinigan Black is quite different in its physical properties from the carbon black made by other methods, having, for instance, a higher electrical conductivity which is of advantage when it is used in dry cells and for similar purposes.

These are the principal products of Shawinigan Chemicals and the plant that builds them up out of coal, limestone, air, and water. Besides, there are numerous chemicals which occur as by-products of the main reactions. Some of these are mere laboratory curiosities at present, but uses have already been found for others which are being marketed, and research is continually adding to the latter. Their names sound like a page from a Greek dictionary, a few of the more common ones being: acetonylacetone, dimethyl furane, dihydroparatolualdehyde, terephthalic acid, 1.3 butylene glycol diacetate, croton aldehyde, and crotonic acid. These, and many others with still more unutterable names, are old friends to the Shawinigan chemists.

While the raw materials for all these chemicals are, as previously stated, coal, limestone, air, and water, the useful chemicals resulting are organic compounds of many and increasing kinds. As with a living organism, the plant of Shawinigan Chemicals is capable of a growth and of a diversity of functions such as but few industrial enterprises can command. Its products can be changed to suit the changing times; and to their number there is apparently no end.

STORAGE FOR CHEMICALS

Four of the ten tanks in this building that provide storage capacity for 2,000,000 pounds of chemicals. The tanks are made of aluminum, and each is 10 feet in diameter and 40 feet long.

CARTAGENA HARBOR SCENE
The profusion of small craft of varied kinds that plies the waters is evident in this view. The harbor is not only spacious but also protected from ocean-born storms by a large island, Tierra Bomba.

The New Port of Cartagena

Extensive Improvements of Colombia's Ancient Maritime Stronghold Increase Her Importance in World Trade

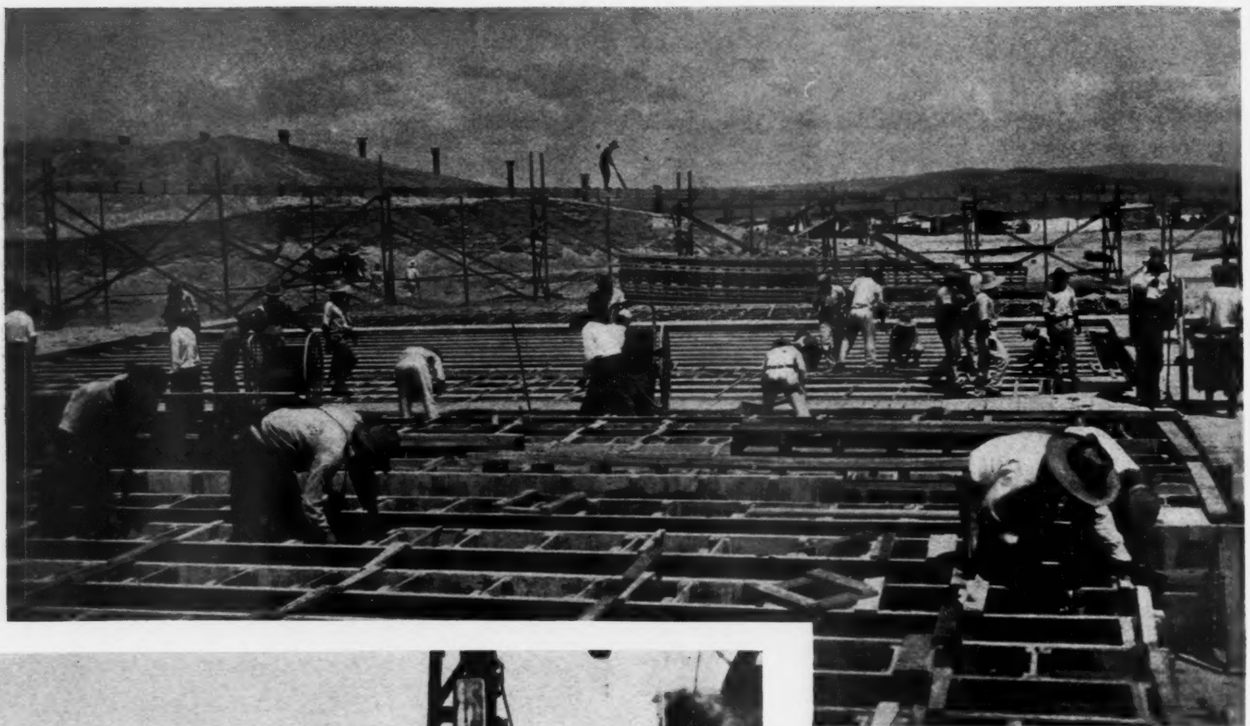
ROBERT G. SKERRETT

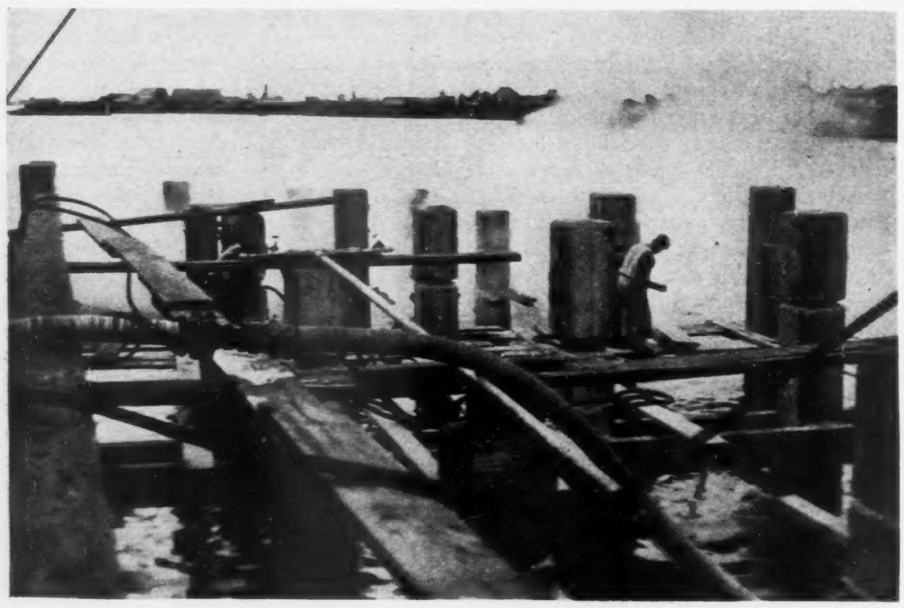
CARTAGENA, one of the oldest of Colombia's seaboard cities, has recently commemorated the four-hundredth anniversary of her founding by Pedro de Heredia. At the same time, Cartagena celebrated the completion of certain harbor works that give the port a revived importance in the promotion of Colombia's foreign commerce. American engineers and constructors, in collaboration with the energetic Colombian government, have been instrumental in making Cartagena better able to serve the country's vast hinterland which abounds in natural riches.

Cartagena, thus equipped with modern facilities wherewith to reclaim her erstwhile maritime preëminence in that part of the Caribbean Sea, reminds us afresh of those glamorous days when she enjoyed the proud status of the principal port and stronghold of Spanish America. Strange as it may seem, it is nevertheless a fact that some of the means adopted nearly two centuries ago to safeguard Cartagena from hostile approach from the sea ultimately crippled her in the race for world trade.

For generations following the founding of Cartagena, in 1533, galleons laden with colonists and Spanish goods arrived at Cartagena twice yearly; and, likewise every six months, the ships that had brought silks, satins, fineries of all sorts, and many other luxuries and essentials from Europe, carried back with them heavy cargoes of rare woods, emeralds, gold, and other precious gems and minerals. Cartagena flourished while the coffers of Old Spain were filled from the treasureland which Columbus had made known to his royal patrons. It was inevitable that other nations should look with covetous eyes upon Cartagena, and it was equally inescapable that the buccaneers of the Spanish Main should lie in wait for the richly laden galleons and even attack and sack that favored seaport. Indeed, Cartagena was so ravaged by pirates from time to time that Spain, in the eighteenth century, erected a formidable array of masonry defenses there and armed them with cannon of ample power and in sufficient numbers to hold them at a safe distance. These fortifications cost Spain more than $60,000,000 in gold; and with those walls and guns Cartagena was able to resist the attack made by the British under Admiral Vernon in 1741. Many of the old defenses are still standing: their last test came in 1815, during the War of Independence, when the city held out for four months against the besieging Spanish forces and surrendered only when well-nigh all the defending soldiers and the majority of the civilian populace had perished. It was that gallant resistance that won for Cartagena the title of "The Heroic City."

Cartagena can justly claim to have one



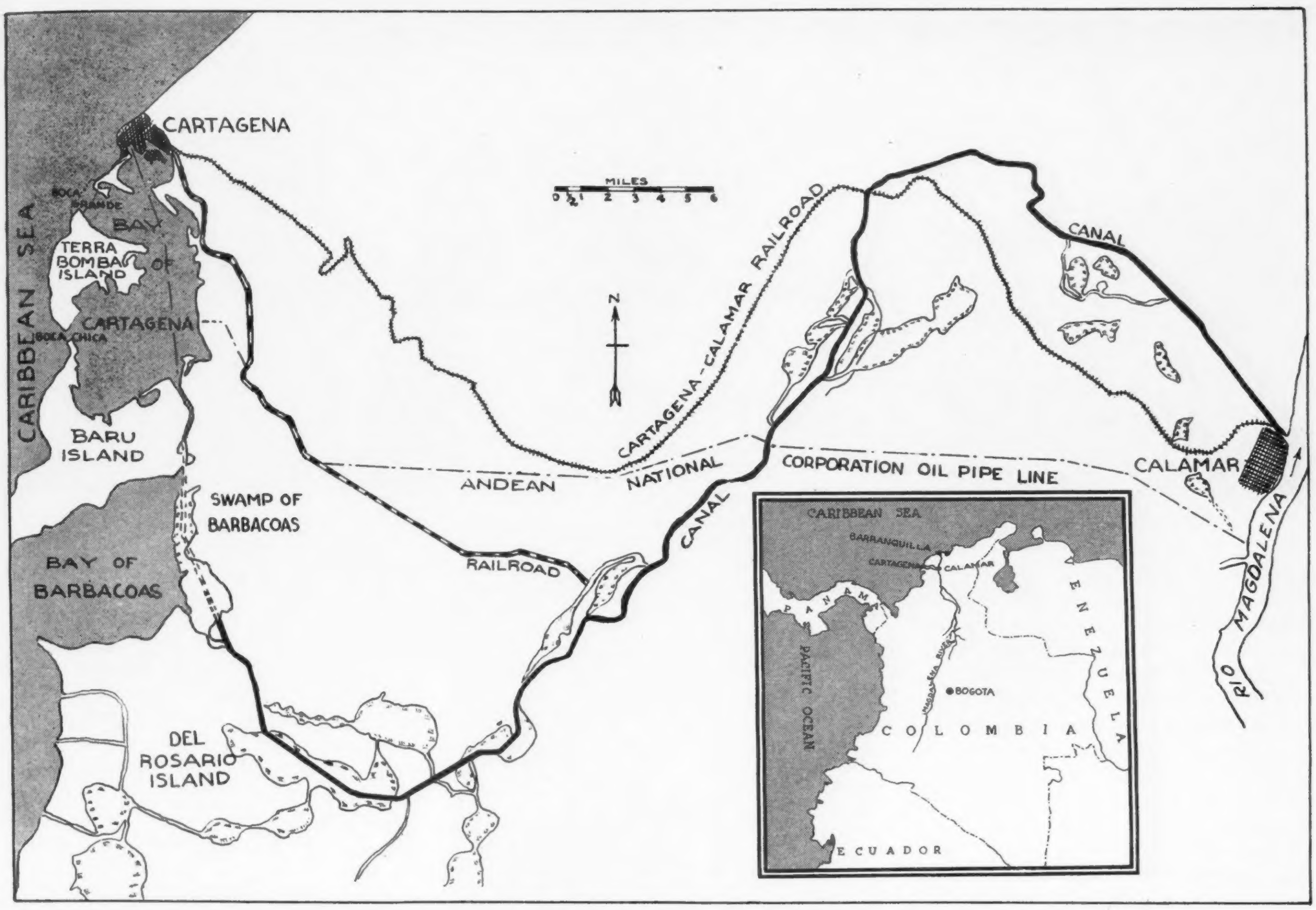


PILES FOR HARBOR WORKS

These pictures show the sequence of casting and driving the reinforced-concrete piles which support the new piers and bulkhead. These piles are from 55 to 70 feet long and were driven to refusal by 5-ton hammers. After they were in place, those that extended above grade were cut off by means of air-operated chipping hammers.

of the most spacious and beautiful of harbors. From north to south the Bay of Cartagena is 14⅓ miles long, and it has a maximum width of more than 5¼ miles. Its midlength is protected from the sweep of the open ocean by a large island known as Tierra Bomba. A wide opening north of the island—Boca Grande—was for many years the easiest and shortest passage in and out of the harbor. South of Tierra Bomba nature provided a narrower, winding channel in and out of the bay. That passage, known as Boca Chica, is about nine miles to the south of Cartagena. The better to protect the city from hostile craft, the Spanish Government, in the eighteenth century, closed Boca Grande to navigation by blocking that channel with obstructing rock, placed there at great cost and much labor, and built heavy fortifications on both flanks of the tortuous Boca Chica.

These various defenses served their primary purposes; and the longer approach to the port via Boca Chica did not seriously interfere with trade in the leisurely days of sailing ships—especially prior to 1831 when Colombia, then designated New Granada, was established within her present territorial limits. But there came a day when time did count in competing for maritime business, and Cartagena suffered by being less accessible to merchant craft than some



GENERAL LOCATION MAPS

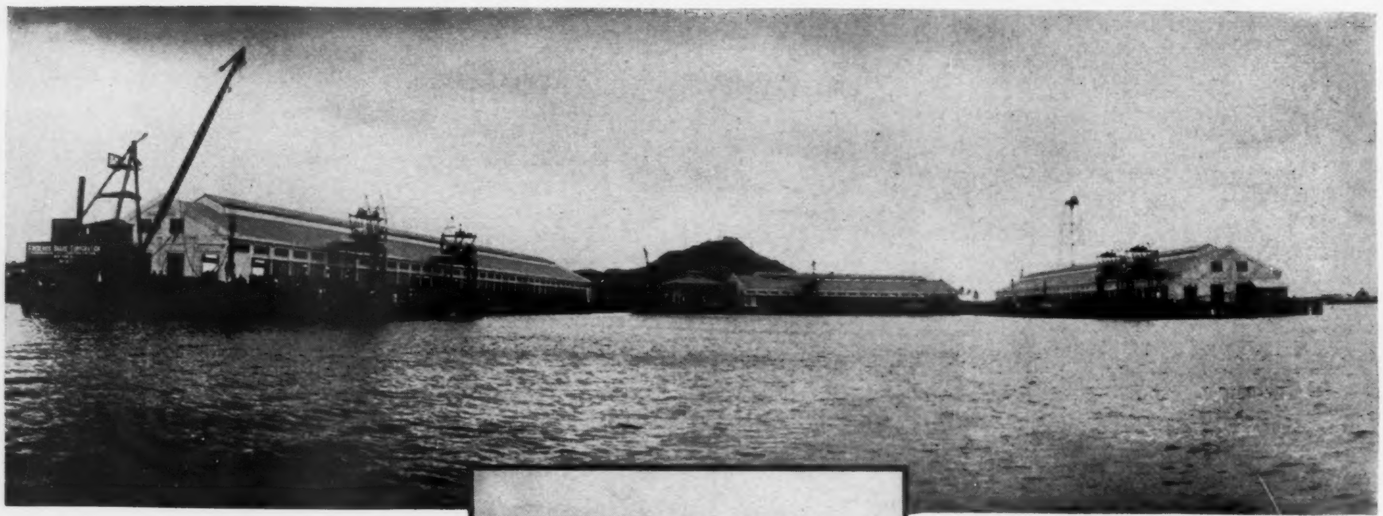
The larger sketch shows the importance of the Port of Cartagena by virtue of the 87-mile canal which links it with the Magdalena River. Barranquilla, at the mouth of the river, has no direct connection with the open sea because its harbor entrance is blocked by a bar which has defied removal. Accordingly, ship-borne goods bound to or from the interior must either be transshipped seventeen miles by rail to or from Puerto Colombia or take the canal route via Cartagena. The Magdalena extends for 1,000 miles into the interior and is navigable to sizable ships for about half that distance. Colombia, fourth in size among the South American countries, has an area a little greater than that of the combined states of Texas, Arizona, and Oklahoma.

other seaboard cities a few tens of miles away. Not only that, but before 1891 ocean-going vessels had to unload and load by means of lighters, and there were no wharves at which they could tie up to facilitate the transfer of freight. That situation inevitably added considerably to the cost of handling imports and exports. This has been especially true of commodities originating beyond Cartagena or destined for points in the interior of the country. Thus the city, originally favored by nature for development as a great *entrepôt*, was hampered by the closing of Boca Grande and was eventually outstripped by Barranquilla, even though that port, which has to make use of Puerto Colombia, does not possess the physical advantages of a land-locked harbor such as has Cartagena.

The Magdalena River is Colombia's great artery for water-borne transportation to and from the Atlantic Coast. It reaches far into the rugged interior of the country which, because of its heavy grades, has made the construction of railroads difficult and their operation expensive. Steamers of fully 500 tons run between Barranquilla and La Dorada—a trip of 514 miles; and by that route the major volume of Colombia's exports and imports is moved. Although Barranquilla is on the Magdalena and near its mouth, still vessels cannot enter that port from the sea. Navigation is blocked by a bar at the river's mouth; and up to the present time that barrier has defied all efforts to open and to maintain a channel for shipping. Outbound cargo arriving by river craft must either be discharged at Barranquilla and transshipped by rail to Puerto Colombia, seventeen miles away on the coast, or be diverted to Cartagena, 50-odd miles away. This procedure is reversed in the case of imports. On the other hand, Cartagena is connected with Calamar, on the Magdalena, by rail and by canal. The latter is known as "El Dique," and was originally developed by the Spaniards. It has long linked Calamar with Barbacoas Bay, which immediately adjoins Cartagena Bay.

El Dique traces its course for a distance of about 87 miles through a succession of swamps and lakes which, to a considerable extent, have provided a natural channel that is navigable to only rather small boats and, therefore, of but little value as a means of transporting bulky freight. Since 1923, however, much work has been done on the canal to convert it into a really important water route for commerce. Within the past two years its usefulness has been tremendously increased by the excavating of Barbacoas Cut. This cut is seven miles long and provides a sheltered route for canal boats which previously had to cross a stretch of open water directly exposed to the sea. Not infrequently traffic was halted until wind and waves subsided. The new cut by-passes Barbacoas Bay and extends through swamp lands between the sheltering islands of Baru and Rosario. The minimum depth is now 11½ feet, and this is sufficient for use by decidedly sizable river craft.

In order that we may fully realize what has been done at Cartagena to make the port a truly modern one, it should be recalled that prior to 1891 Cartagena did not have a single pier at which a seagoing ship could be moored. During that year a wooden wharf, known as "La Machina," was built and provided with a rail connection. That made it possible to load and unload directly without employing lighters, as had



THE HARBOR IMPROVEMENTS

At the left and right, top picture, are the two new piers, each 600 feet long and 130 feet wide. In the center, just inshore from the bulkhead, are the administration building and the central warehouse. El Dique, the canal that joins Cartagena with the Magdalena River, has been dredged recently to a minimum depth of 11½ feet, thus permitting its use by fairly large river boats. Throughout much of its course the canal traverses inland lakes and swamps. A section of it is shown in the lower view.

previously been necessary. La Machina helped Cartagena immediately, and also enabled the port to do a certain amount of business in the general foreign trade of the republic. Unfortunately, the wharf was swept by fire in 1930, and for all practical purposes destroyed. Thereafter, goods had to be transshipped by lighters, and this both slowed up and added substantially to the cost of handling inbound and outbound freight. Now for the transformation that has been wrought since April 28, 1932.

Recognizing the strategic location of the port, and with a full grasp of the present and potential importance of Cartagena to the economic development of the entire nation, the Government of Colombia, through President Enrique Olaya Herrera and the Minister of Public Works, Alfonso Araujo, decided to reconstruct the harbor along modern lines. The Frederick Snare Corporation, contracting engineers of New York City, was selected to investigate the problem and to design facilities that would best meet existing and future needs; and to this same experienced organization was later entrusted the work of virtually creating a new port in accordance with the plans submitted by that company after they had been carefully checked and approved by Dr. Germán Uribe Hoyos, former Minister of Public Works and recognized as one of Colombia's most illustrious engineers. Construction was started in May, 1932, and carried forward with such expedition that the project was an accomplished fact and ready for service on November 1, 1933.

The waterfront is now made secure by a concrete bulkhead, 33 feet wide and 1,065 feet long, from which extend out into the harbor two reinforced-concrete piers each 130 feet wide and 600 feet long. For the storage and the inspection of cargo, each of these piers carries a steel shed equipped with a complete system of fire protection, including pressure tanks, automatic pumps, and alarm stations. There are two electric cargo cranes on each pier for loading and unloading river craft and lighters, and on the bulkhead are other cranes—one of which has a capacity of 15 tons for heavy lifts. A 20-ton floating derrick, tugs, lighters, conveyors, piling and stacking machines, and other apparatus and equipment are provided to round out the port's facilities. Rail connections are made with the Cartagena-Calamar Railway and with the Central Bolivar Railway, the tracks running out on the piers for either direct loading or the transshipment of freight. Just inshore of the waterfront bulkhead is a third storage shed and an administration building of ample capacity.

The space between the two piers is substantially 400 feet wide. One of the slips and its entrance channel have been dredged to a minimum depth of 39 feet below low tide, and this assures sufficient water alongside the piers for the accommodation of the largest steamers. The other slips have been cleared to 33 feet at low tide. The material that has been dredged from the harbor bed has been deposited between the concrete bulkhead and the old shore line; and in this manner has been built up 23 acres of land for the arrangement of track connections and for storage purposes.

The excavating of the Barbacoas Cut, the improvement of El Dique, and the deepening of the harbor channel and the slips on both sides of the new piers have been done by a dredge that has well demonstrated her seaworthiness by traversing long stretches of open ocean. This vessel was towed 3,500 miles from the Port of New York to Callao, Peru, and had just completed her work in Callao when the Frederick Snare Corporation was awarded the contract for the betterment of the Port of Cartagena. Accordingly, she voyaged northward along the Pacific Coast of South America and again through the Panama Canal to reach her new scene of operations. In deepening the harbor, in digging the cut, and in improving the canal, the Frederick Snare Corporation has dredged all told 2,500,000 cubic yards of material. To make Boca Chica better suited to present-day requirements, that naturally narrow and winding waterway was dredged a few years ago to a depth of 40 feet, and the channel is now 500 feet wide and straight.

In order to carry on the work in an efficient manner, the Frederick Snare Corporation had to create a camp for a large number of its employees and to erect a suitable plant for the washing and the screening of sand and gravel for concrete. Furthermore, an area had to be set aside and properly equipped for the casting of some thousands of reinforced-concrete piles that support the piers and the waterfront bulkhead. The piles are rectangular in cross section, measure 18x18 inches, and vary in length from 55 feet to 70 feet. They were driven to refusal in the underlying hardpan with 5-ton Vulcan steam hammers. As many as

600 piles were cast in the course of a month; and at the peak of activities, 700 were sunk in 30 days. After casting, the piles were seasoned for a suitable period before driving.

While operations at Cartagena did not call for the excavating of ledge rock—although the contractor had air-driven drills available for that purpose, nevertheless compressed air was variously and frequently used. For example, the reinforced-concrete piles were often overlong, and the excess projecting above water or the beach after placing was cut off with chipping hammers. Similarly, concrete in various locations had to be trimmed and drilled to make prescribed adjustments or to install apparatus and fittings of different kinds, and woodborers and other labor-lightening pneumatic tools were employed in preparing timber for a multiplicity of services. All this equipment was of Ingersoll-Rand make, as were the portable compressors. At the climax of the work, a force of 500 men was on the job.

Under the contract, the Frederick Snare Corporation was obligated to complete the undertaking within 24 months from the start of operations; but by reason of the coördination of the work and the energy displayed at all times, the task was finished within the remarkably short span of eighteen months. Because of this expedition, the new facilities of the Port of Cartagena were ready for service and yielding revenue six months sooner than expected. The contract was for a lump sum of $2,850,000—the ultimate capital necessary for carrying out the project being contributed jointly by the Colombian Government, the Andean National Corporation, and the Frederick Snare Corporation. It is reasonable to assume that the new port facilities will produce a substantial increase in revenue, thus making the undertaking self-liquidating and in no wise a burden on the federal treasury. With the greatly improved service now at the disposal of shipping, and at lower rates than have heretofore prevailed at Cartagena, that port should recover its erstwhile maritime position. Colombia's commerce with the world at large has been steadily mounting in latter years.

REMINDERS OF FORMER DAYS

During colonial times, Spain spent more than $60,000,000 at Cartagena erecting fortifications so as to repel the pirates that infested the Caribbean waters. At the top is a section of the old wall, La Bovedas. Cells within that structure of defense were filled with patriots during the War of Independence. It is antedated by the Fortress San Fernando, built in 1759 to resist attacking fleets of enemy nations. A portion of that bulwark is still standing and is shown in the lower picture.

For those who may not have a clear conception of Colombia's geographical features, let us remind them that that republic has nearly 500,000 square miles of land on which can be raised well-nigh all the products of the world. A similar area in the United States would embrace our Atlantic seaboard states from Maine to Florida, with the addition of Ohio and West Virginia. Colombia is the third largest country in South America. Even though lying within the tropic zone, she has a range of climate extending from that of torrid jungles to that of perpetually snow-clad mountains. She is especially rich and varied in her horticultural abundance, being first in the production of mild coffee and third in the growing of bananas. She is the greatest source of emeralds, ranks second in the output of platinum, and her mines exceed those of any other South American nation in the production of gold. Colombia promises to be one of the world's most important sources of petroleum. In 1932, her oil output amounted to 16,414,000 barrels, and her exports totaled 15,320,000 barrels valued at $16,437,783. A pipe line 335 miles long, owned and operated by the Andean National Corporation, runs from the interior of Colombia to Cartagena Bay. It has a daily capacity of 50,000 barrels.

Within her forests, besides such timber as cedar, mahogany, balsa wood, lignum-vitae, etc., are to be found medicinal barks, balsams, gums, rubber, chicle, ivory nuts, tanbark, and numerous other valuable commodities; and upon her expansive grazing lands there are about 7,500,000 head of cattle. In addition to the minerals already mentioned, Colombia has great deposits of silver, copper, iron, tin, cinnabar, lead, nickel, coal, and asbestos. Indeed, Colombia is just coming into her own in the development of her resources and in winning her logical share of world trade; and the outlook for Cartagena, with her modernized port facilities and readiness for the demands that will inevitably come, is in truth a very encouraging one. Already, this historic city is feeling and responding to the urge of the times. Even so recently as 1912 her population did not exceed 36,000. Six years later, her people numbered 51,000. Today she has within her limits a population of nearly 93,000.

As she stands today, Cartagena commingles in a fascinating way picturesque evidence of the centuries gone and those tokens that mark the intervening march of progress. To the tourist, Cartagena and Colombia generally should and will undoubtedly make a strong appeal. In that veritable "Treasure Land," where Old Spain still lives in many ways, one follows in the footsteps of Columbus and the conquistadors.

CEMENT BY PRESCRIPTION

BY THE use of a patented process developed by C. H. Breerwood, vice-president of the Valley Forge Cement Company of West Conshohocken, Pa., it is now possible to manufacture cement of a definite chemical composition. These results are obtained by grinding the raw materials, separating them, and recombining them in the exact proportions desired. The process is now in use on a production basis, and the savings which it effects are reported to more than offset the increased costs entailed.

Because of minor variations in raw materials, no two cement-mill clinkers are alike, and the product of one mill may change perceptibly from day to day. Fairly close control can be exerted over the finished cement by adding to the raw mix additional quantities of any constituent in which it may be deficient; but precisely proportioned mixtures have hitherto been unobtainable, save in the laboratory. This variation can be and is overcome to some extent by blending the product of many days' run. However, the method put forward by Mr. Breerwood makes blending unnecessary and enables the chemist to ascertain in advance just what kind of cement he is going to produce.

The Breerwood process enlists methods and machines that have long been used in treating ores. Briefly stated, it consists of classifying and segregating the various constituent minerals of the raw mix. Either wet- or dry-type separators may be employed in conjunction with froth flotation units. Details of the treatment must be altered according to the composition of the raw materials, but tests conducted at the Valley Forge plant with cement rocks from different parts of the world indicate that all are susceptible to handling in the new manner. It also appears that, by selecting the appropriate flow sheet in each case, grinding costs can be materially decreased and a uniform product of definite and determinable chemical make-up turned out at the same time.

NOTABLE CAREER CLOSES

THE DEATH on November 3 of Sir Robert McAlpine at the age of 87 years removes one of England's most outstanding constructional engineers and builders. His life story reads like a romance. He began his career as a doer of odd jobs in a coal mine when he was fifteen years old. Yet he founded a great company and executed during the next half-century engineering contracts valued at $500,000,000.

Among the almost countless projects which he carried to completion were the Wembley Exhibition Buildings, the $15,000,000 Tilbury Docks, the palatial Dorchester Hotel in Park Lane, London, the Spondon factories and housing schemes of the British Celanese Company near Derby, and the vast Singer factory at Clydebank.

Much of his success arose from his readiness to try new methods and materials. He was a pioneer in the use of compressed air and reinforced concrete; and such was his fondness for the latter material that he has been buried in a finely wrought concrete mausoleum designed and built under his personal direction some years ago.

Thirty-eight members of the McAlpine family, including Sir Robert's sons are now active in the firm which bears his name. His sons share alike in the business, their father having decreed that they shall be either equally poor or equally wealthy.

OUR COVER PICTURE

THIS striking underground mining view shows an Eimco-Finlay loader working in a stope of the Lakeview & Star Mining Company in Australia. Details of this loader, which is made by the Eastern Mining & Metal Company of Salt Lake City, Utah, were given in our February, 1933, issue. Its operating power is supplied by two 5½-hp. compressed-air motors.

BIRTHDAY FELICITATIONS

IN THE spring of 1884, J. R. Marks and "Billy" Hart quit their placer diggings in Buckskin Gulch, Idaho, located a lot in the Town of Murray, and erected thereon a 25x40-foot frame building. Upon its front they nailed the sign: "J. R. Marks & Co.—Hardware Merchants." A little later they took in E. H. Moffatt as a partner and opened branch stores at Wardner, Burke, Mullan, and Wallace. Subsequently, four of these establishments were sold, and efforts were concentrated on the Wallace store.

In 1891, Dr. T. G. Heine of Phillipsburg, Mont., decided that the Coeur d'Alenes needed a foundry, and he proceeded to provide one at Wallace, the equipment being shipped in over the shiny new rails of the Northern Pacific Railroad. Drawings or measurements of the machinery in use at the lead-silver mines were secured and patterns prepared from them. Coke and pig iron were imported from Pennsylvania and, in 1892, the foundry started operating.

The two concerns thus born, eventually were merged into the Coeur d'Alene Hardware & Foundry Company, which is today the largest industrial firm in Idaho. In attaining the ripe old age of 50 years in a new country, the company experienced many ups and downs. Three times fires wiped out one of its component concerns lock, stock, and barrel, but a new and better building arose each time.

Mining men throughout the West know the firm and its products. It makes many things which are vital to the mining and milling of ores. Its crowning achievement was the manufacture of the 800-hp. hoist which raises all the ore of the Bunker Hill Mine, one of the nation's greatest lead producers. It is the foremost "trouble doctor" of its section, and prides itself on the speed with which it can duplicate a broken part of a machine essential to putting some unfortunate mine or mill back into production.

HANDY PORTABLE CLEANER FOR COMPRESSED AIR

IN CLEANING the inner works of motors, generators, switchboards, engines, etc., with jets of compressed air it is important that the air be free from oil, moisture, and dirt if it is not to defeat its own purpose. In other words, if they are not removed it simply means blowing the accumulated dirt from commutators, brushes, switch points, polished bearing surfaces, etc., and leaving in its stead impurities that may be more harmful than the original deposit. With this in mind, the Hagan Corporation, Pittsburgh, Pa., has developed a portable compressed-air cleaner that can be wheeled easily to the point of application—the only point, as the manufacturer stresses, where it is possible to remove from the air all the entrained foreign matter.

The new air cleaner, as the accompanying illustration shows, consists of a tank—a section of standard 8-inch pipe—with semisteel heads held in place by ¾-inch through bolts. Mounted in the upper part of this tank is a Hagan centrifugal separator of the type used on the U. S. Dirigible *Macon* and built under rigid U. S. Navy specifications. All impurities removed from the air in its passage through the separator are retained in the tank, which is provided with a gauge glass so that the operator may know at a glance when it requires draining. This can be done quickly by turning a valve at the bottom of the tank. On opposite sides of the cleaner are hose racks carrying, combined, 50 feet of

air hose—25 on the air-inlet side and 25 on the discharge side. The latter terminates in a pistol-type valve nozzle.

The Hagan air cleaner is as easy to handle as a vacuum cleaner; can be attached to any air outlet; and is always ready for service. It was designed especially for power houses where there is a concentration of the aforementioned equipment, but can, of course, be used anywhere where compressed air is available and where that medium alone can be counted upon to reach the inaccessible parts of machinery and to remove the dirt which, if permitted to accumulate, would reduce their operating efficiency.

COMPRESSED AIR OF SERVICE IN BUILDING LIGHTNING ARRESTERS

POWER-STATION lightning arresters are heavily taxed and must be proof against moisture, which is their worst enemy. Elaborate precautions are therefore exercised in their construction so that they will be effectually sealed and able to perform their dual function of reducing surge voltages to values that will not harm the apparatus being protected and of acting as insulators after the surge has been discharged.

Station arresters consist essentially of two parts: the gap and the arrester elements. The gap is a completely insulated structure in a porcelain casing which is tested for tightness with compressed air before the gap elements are inserted, whereupon the unit as a whole is submerged in water and subjected to high-pressure air—leakage being indicated by escaping air bubbles. This is followed by a special dry-air treatment, after which the assembly is filled with air dried and tested for dew point at −58°F The latter measures are taken in order to prevent internal condensation.

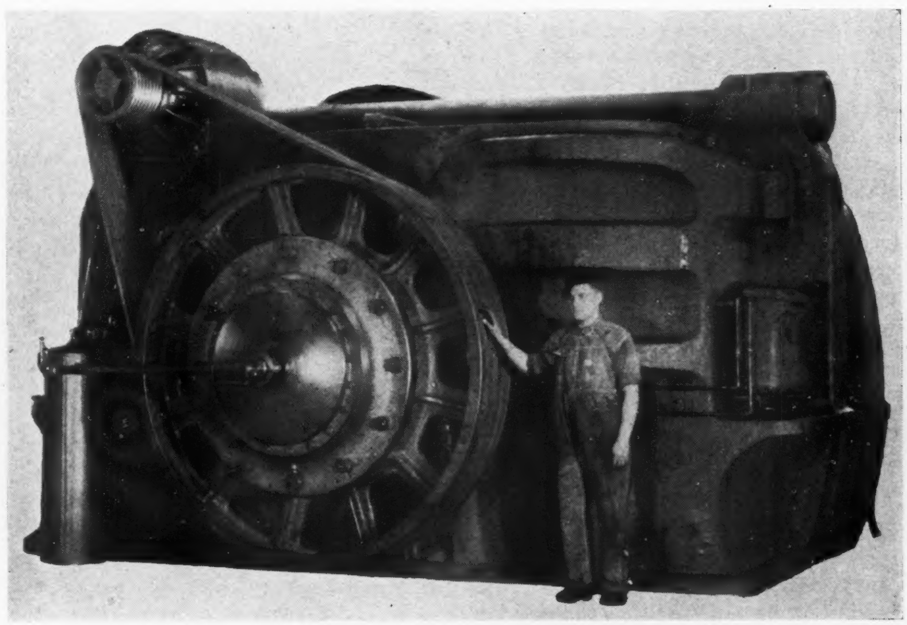
The arrester elements are also encased in porcelain and, although they are not as susceptible to moisture as the gap elements, they are carefully sealed and each unit given the same routine pressure test. The finished product, as can be appreciated, is as waterproof as it is possible to make it, with the result that it can be depended upon to rob lightning of its destructive power.

AIR CLUTCH FOR HEAVY-DUTY FORGING MACHINE

FOR starting and stopping its heavy-duty forging machines, National Machinery Company, Tiffin, Ohio, offers a new and simplified type of air clutch as alternate equipment for the quadruple-abutment clutch. While the latter is highly efficient, the pneumatic clutch eliminates the noise caused by the pick-up when the clutch block engages the abutment in the gear.

Pressure is applied to the friction disks by a large-diameter air plunger which forces the plates together quickly, thereby avoiding the heating that is experienced with a clutch that operates slowly. Multiple disks of unusually large area are employed to hold down the unit pressure and to maintain a low temperature even when they are tripped at frequent intervals. When the pressure is released, compression springs both expel the used air and separate the plates to reduce wear and to prevent heating. A small amount of low-pressure air is required to operate the clutch effectively.

In combination with the air clutch is employed a so-called "friction-slip relief." This is a separate safety unit and serves to relieve overloads on the machine. This makes it possible to use a large-capacity, oversize air clutch and one that does not have to act both as a driving medium and a slip relief, as is generally the case. Air clutches of this type are being built in a full range of sizes and for other purposes where great driving torque and fast operation are demanded. The accompanying photograph of a 6-inch National forging machine shows the generous proportions of the clutch.



Industrial Notes

Paints containing powdered cork are especially well suited for the coating of surfaces that should be protected against rust and corrosion or insulated against heat and sound.

The Goodyear Tire & Rubber Company, in coöperation with the Department of Parks of Akron, Ohio, has produced a plastic rubber for filling cavities in trees.

Although Texas is a storehouse of natural gas and fuel oil, the University of Texas finds it more economical to burn lignite in its steam plant. The lignite reserves of the state are estimated at 23,000,000,000 tons, most of which remains untouched.

De-aired paving brick, which is made of clay from which the air has been exhausted by passing it through a vacuum chamber, is becoming popular because it is said to be stronger and less absorptive than the older product and can be turned out with a far smaller number of rejects.

Statistics show that 38,921,000,000 kw-hrs. of electricity was produced in the United States in 1919 at a fuel output of 3.2 pounds of coal per kw-hr. Compare this with 1.47 pounds of coal burned for each of the 85,402,000,000 kw-hrs. developed in 1933.

An electro-pneumatic horn that is self-contained is being offered by the Federal Electric Company of Chicago, Ill. The horn is mounted on top of a small motor-driven compressor and is so arranged that it can be connected to any shop fire alarm or other signaling system.

X and Y are two forms of a heat-resisting metal produced by the Kux-Lohner Machine Company of Chicago, Ill. The material is said to be well adapted for the manufacture of annealing boxes, melting pots for nonferrous metals, oven and furnace doors, fire boxes, stoker parts, etc.

Something entirely new in glazed windows especially suitable for air-conditioned structures is being sponsored by the Libby-Owens-Ford Glass Company. The windows consist of two panes of glass so fitted in the sash as to leave an intervening air space that serves to check the flow of heat and cold. The product is called Thermopane.

To prevent contamination, many producers of foodstuffs now depend upon the metal spray gun to keep filters, coolers, tanks, mixers, and other containers in condition for use. Equipment of this kind is coated with tin, and the metallizer in question not only assures a coat of uniform thickness in the first place but makes it possible to retin worn surfaces without difficulty.

Galvanized iron or cadmium-plated surfaces treated with Granodine or Lithoform, two new products, can be given a coat of paint that will stick, says their manufacturer. Parts that are comparatively small in size are dipped in a hot bath of Granodine, while Lithoform is applied by brush or spray. The surfaces are ready for painting as soon as they have been washed and dried.

Dr. S. S. Kistler, professor of chemical engineering at the University of Illinois, has produced a light-weight insulating material which he calls "silica aerogel" and which has been described as a fine network of pure sand interlocked with air. It is said to withstand a temperature of 1,500°F.; and its insulating properties are estimated to be 10 per cent higher than those of still air and from 50 to 100 per cent greater than those of most of the materials of this kind now in use.

About six years ago, the Bureau of Standards exposed to the weather a large number of steel panels surfaced with two coats of red-lead paints. These consisted of 20, 22, 25, 28, 30, 33, 35, and 40 pounds of red lead, 95 per cent grade, to 1 gallon of boiled linseed oil without a thinner or drier; and the panels were set facing 45° south. So far the paints are standing up in the order in which they have been mentioned, the first to fail being that containing the least red lead. After a lapse of 5½ years, the last four are still in good condition.

The horse: "Gosh! Do the flies bother her, too?"

The fourth installment of the *Story of the Boulder Dam*, which is being published by the Ingersoll-Rand Company as work on this vast project progresses, is ready for distribution. This 47-page, well-illustrated booklet contains descriptions of the cofferdams, of the aerial cableways, and of the tunnels for the penstock headers, the penstocks, and the canyon-wall outlets. It also deals with the method of pouring the concrete and tells how the concrete is cooled after pouring. Copies of Volume Four can be obtained from the Ingersoll-Rand Company, 11 Broadway, New York, N. Y., which is supplying much of the compressed-air equipment used on the job.

Rubber cement sprayed on mold surfaces gave highly satisfactory results, it is reported, in making two large bronze plaques for the entrance of the National Bureau of Standards in Washington, D. C. The tablets bear legends in raised letters on a matte ground. Regular foundry practice did not produce good results for several reasons, including a slight washing of the sand. The difficulties were overcome in the bureau's experimental foundry by coating the mold walls with rubber cement. This caused the fine surface particles to adhere, thus assuring an accurate reproduction of the details of the plaque. It was possible by this procedure to cast the metal in a green-sand mold. Letter Circular No. 25, which may be obtained without charge from the bureau, describes the use of rubber cement as a binder for foundry cores.

Langley Field, Va., is to have a wind tunnel capable of resisting the tremendous forces of a gale blowing at a velocity of 500 miles an hour. The structure is to be a part of the laboratory of the National Advisory Committee for Aeronautics, and is to be 154 feet long, 51 feet wide, and 25 feet high, with a test chamber 8 feet in diameter. Its reinforced-concrete walls are to be lined with steel plates, and a total of 8,000 hp. will be required to simulate a wind of the desired velocity. With this tunnel it is proposed to study the natural laws governing air flow exceeding 200 miles an hour so as to increase airplane speeds. It has been determined through research that flying machines can make 500 miles an hour and more; but, in the absence of the knowledge that is to be sought through the medium of the new wind tunnel, the present safe speed limit is 200 miles an hour.

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INDEX to VOLUME XL

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Ewing Galloway Photo

HOBART AND ITS HARBOR

Hobart is the principal city of the island, with a population of about 60,000. Tasmania is a new country, having been known to white men only since 1642. Its discoverer, the Dutch navigator Abel Janszoon Tasman, called it Van Diemen's Land, in honor of his patron. In 1853 the name now applied to it was adopted.

credited with having been primarily responsible for the rise of the island's copper-mining industry. Its Royal Tharsis Mine is a low-grade copper property situated in the western foothills of Mount Lyell. It was originally worked some 30 years ago by quarrying the surface outcrop, and was explored to a depth of 200 feet. The ore was used as a flux in the pyritic smelting process, and when it was no longer required for that purpose its production became unprofitable and the mine was abandoned. Subsequently, however, a tunnel, known as the North Lyell, was driven 7,000 feet to connect the treatment plant of the company with the 1,100-foot level of the North Lyell Mine. At a point about 5,000 feet in from the portal, this tunnel passes almost directly beneath the old workings of the Royal Tharsis and at a level 866 feet below the surface. From this opening the ore body was located by means of drifts and diamond-drill holes, its limits defined, and its values determined. The dimensions and assays thus obtained conformed with those at or near the surface, thus indicating that the deposit was uniform between the two levels. The ore body is a lenticular mass of copper-bearing schist which contains 2¼ per cent copper and 0.02 ounce of gold to the ton. It is 500 feet long and ranges from 70 to 100 feet in width. It dips or slopes at an angle of about 60 degrees.

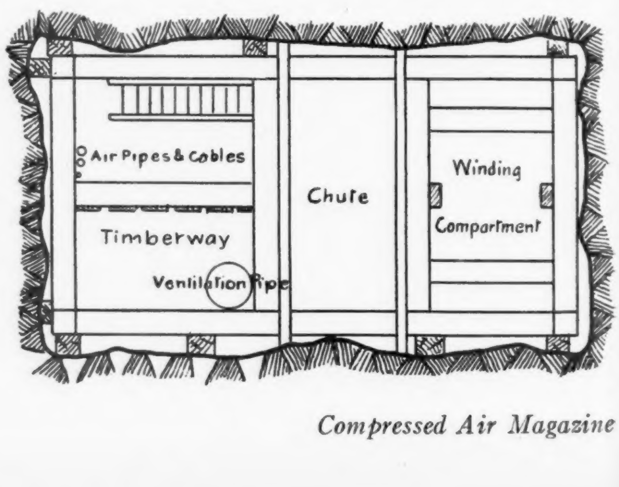
Because of the better facilities for working the deposit that were afforded through the completion of the North Lyell Tunnel in 1928 and of the advances in metallurgical practice that had been registered since the Royal Tharsis abandonment, it was believed that the property might be profitably exploited. Accordingly, the ore body was fully opened up at the tunnel level, and stoping of the cut-and-fill type was begun. This was a desirable scheme of mining, inasmuch as it obviated the need of hoisting ore and, also, of pumping water. It was apparent, however, that in order to open levels in the overlying ground, to transport men and materials to the higher workings, and to secure adequate ventilation of the mine, a shaft connecting the tunnel level with the surface would have to be provided. This having been determined, it remained only to decide whether it would be better to sink the shaft from the surface or to rise it from the tunnel. A study of this question pointed to the following advantages to be gained by the latter procedure: it would eliminate the necessity of building a surface plant in a locality remote from the base of operations; it would make for convenience of supervision as well as in supplying compressed air, water, electric power, and ventilation from the North Lyell Mine by way of the tunnel; hoisting of spoil and pumping of water would be unnecessary; spoil could be used for filling stopes at the tunnel level, thereby aiding maintenance operations there while the shaft work was in progress; and various levels above the tunnel could be opened up, in the order desired, as the shaft was being extended upward. The ultimate effect of all this, it was reasoned, would be faster progress and lower cost than could be obtained by sinking. The possible difficulties of excavating from below were expected to be: raising men and materials to the working face; providing adequate ventilation; protecting timbering in the completed portion from damage by spoil; and coping with any wet or unstable ground that might be encountered. Of the two, the rising method had so many more advantages to offer that it was definitely selected, and details of design and construction were determined accordingly.

The dimensions of the shaft were fixed at 15x8 feet and provided for two cage compartments, each 6½x3 feet, and one pipe, cable, and ladder compartment measuring 6½x5 feet 2 inches. It was decided to use 8x8-inch hardwood for timber and to place it in floors or courses 7 feet high. Each floor consisted of three rows of four legs each, and on top of these vertical members were laid two long caps or wall plates, running longitudinally across the two outside rows of legs, and four cross members—two end plates and two dividers. The plans called for levels at 120-foot intervals, or five between the tunnel and the lowest adit of the old workings that was 146 feet below the surface.

The entire undertaking was completed

PLAN OF SHAFT

The spoil chute in the center was braced on its two boarded sides by timber struts. In the ladderway (left), 1-inch boards arranged vertically were nailed to these struts, dividing the space into two sections. One of these held the ladder, air and water pipes, and cables: the other was used for hoisting timbers and also contained the ventilation pipe—a 15-inch sheet-iron tube through which as much as 2,000 cfm. of air was exhausted. Its upper end was kept within 100 feet of the working face. Drillers were able to return to work within 30 minutes after blasts.



in 71 weeks, or at the average rate of more than 12 feet a week. Its cost was £9,319, or the equivalent of $45,290 at the normal rate of exchange. The cost per foot was approximately $52. This figure takes no account of the value of the spoil as stope-filling material. A noteworthy feature was the small labor force required. Only two men to a shift worked at the face. For the first 36 feet they were paid wages, but after they had thus gained experience they undertook the work on contract. Their payment on this latter basis ranged between $19.50 and $24.30 a foot, and it is significant that for the uppermost 231 feet of the shaft the contract price was less than $22 a foot, or considerably under the maximum. The men operated in three shifts, each group working eleven shifts per fortnight. In addition to the contractors, two special timbermen were employed. They did not work continuously in the shaft, but were subject to call whenever it was ready for timber. Besides wages, they were paid a bonus of $2.50 for each 7-foot floor of timber erected. A hoist operator on each shift, and two trammers on one shift to dispose of spoil completed the working force.

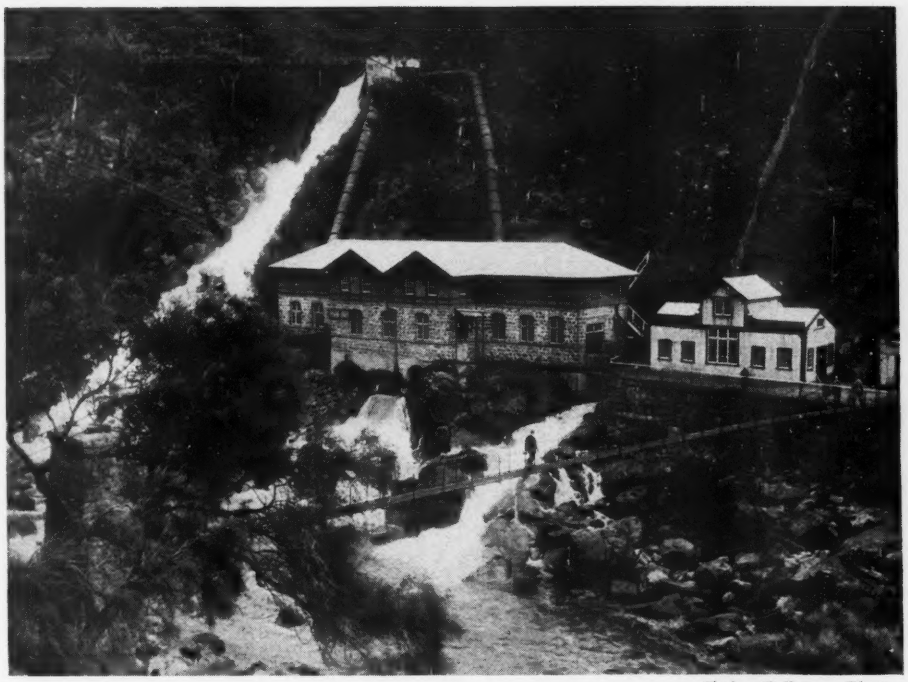
The material penetrated by the shaft was moderately hard schist. This stood well except at one place, 450 feet above the bottom, where a heavy flow of water transformed the rock into a clayey mass. Until this section had been passed, the timber was kept close to the roof.

The shaft was started at a point 80 feet from the tunnel on a prospecting drift from where the opening, it was believed, would clear the northern edge of the ore body throughout its course. The shaft was first cut out full section on one side of the drift and excavated to a height of 20 feet. An opening-out set of timbers, 13 feet high, was then erected, as shown in an accompanying drawing. The center compartment was lined with boards to form a spoil chute, and this was fitted with a door for loading side-dump mine cars of 1-cubic-yard capacity. The cage compartment at one end was left open, and the ladderway compartment at the other end was selected for the installation, besides the ladders, of a 2-inch air line, a 1-inch water line, a 15-inch ventilation pipe, and telephone, light, and signal cables.

Sawed timbers of 8x8-inch section were laid on top of the opening-out set, forming a platform that was continuous save for an 18-inch-wide opening directly over the chute. This aperture was provided for the disposing of blasted material and also gave access to the platform from the ladderway, the top 2 feet of chute lining being left off on the ladderway side.

The first of the series of blast-hole rounds by which the shaft was progressively carried upward was then put in. Two stoper drills, using air at 85-90 pounds pressure and fitted with 7/8-inch drill steel, were utilized throughout. A transverse cut was first made in the center and blasted, after which the sections on either side of it were shot. Details of the drilling round are shown in an accompanying sketch. The main holes were drilled 7 feet deep. The progress per round was about 6 feet, four rounds usually being required to permit the placing of three floors of timbers each 7 feet high.

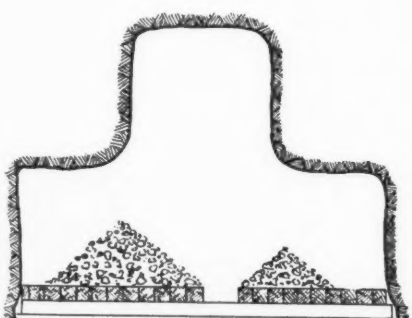
After firing the final holes, the two drillers returned to the platform, barred down any loose rock from the walls or roof, and, whenever sufficient overhead clearance was available, made ready for the installation of another course of timber. Before all the spoil was removed, a stull was wedged across the shaft over the center of the ladderway and near the roof, and a pulley block and chain suspended from it for use in hoisting timbers. For this purpose, a 1-ton compressed-air hoist was mounted on a column situated on the tunnel level below and in a chamber on the opposite



Ewing Galloway Photo

MOUNTAIN POWER HOUSE

Although it is only about as large as West Virginia, Tasmania has varied natural resources. Its mountains reach to extreme altitudes of more than 5,000 feet, and from these higher sections issue streams of great potential power development. The hydroelectric generating station shown here is near Launceston, in the northern part of the island. The western half of Tasmania, which remained unexplored for a long time, proved rich in minerals. The Mount Bischoff Mine, opened in 1871, has been a great tin producer, having paid several million pounds sterling in dividends. Tasmania now produces gold, silver, tin, copper, coal, and other minerals.



GENERAL EXCAVATION SCHEME

After the shaft had been carried upward 20 feet, an opening-out set of timber was installed and floored over as shown. This set had a central muck chute with a door from which to load cars. Drilling was done with stopers, a central cut being first made, as illustrated, and the ends then shot. The spoil was shoveled into the chute through an opening left in the platform. Above the opening-out set, timber was erected in 7-foot courses or floors. Levels were cut at intervals of 120 feet, and at each of these a collar set was placed and another opening-out set installed.

Ewing Galloway Photo

THE GRAY HOUSE

The government of Tasmania is centered in this building at Hobart. Tasmania formerly was used as a penal colony by the British, and a large proportion of its population was convicts. This practice ceased in 1853, and in 1856 representative government was established.

side of the drift from the shaft. The rope from this hoist was led through a pulley at the foot of the ladderway, thence up the ladderway, and around the suspended pulley.

When the spoil had been cleared from the platform, the lagging was removed to expose the mortised openings in the top of the opening-out set of timber, and the members for the following set were then hoisted and placed by the timbermen. The eight wall legs were erected first, and the long caps adjusted, after which the remaining four legs and the cross members were installed. The hoist elevated the eighteen pieces of timber in six trips; and, although the long caps weighed about 450 pounds each, the men became so experienced in maneuvering the various members into position that little lifting on their part was required. The timbers were all dressed at the company sawmill. Each floor set was assembled there and the pieces numbered so that they might be erected in the shaft exactly as planned by the mill carpenter.

After the floor timbers had been placed, the platform lagging was hoisted, four pieces at a time, to the top of the section and relaid. The drills were next hoisted to the new position, and the miners resumed drilling while the timbermen plumbed and blocked the set. About four hours' drilling time was lost whenever a floor was placed, and the timbermen were engaged an average of eight hours during which they lined the spoil chute and equipped the ladderway to the higher level.

The chute was lined on the two sides adjacent to the end compartments, 8x3-inch hardwood boards being laid horizontally. The other two sides along the shaft walls were left unlined to prevent the possible bursting of the compartment under air pressure in the event of its clogging with spoil and the accumulation then suddenly giving way with a rush. The long caps which were exposed were protected by fitting over them shoes made of ⅜-inch steel. The level of spoil in the chute was kept within 20 feet of the top so that those protruding members might not be subjected to the shock of heavy rocks falling from great heights. On its two boarded sides the chute was braced with struts placed across the end compartments. Those in the ladderway were located in the center at 7-foot intervals, and to them 1-inch boards were nailed vertically, thereby dividing the compartment into two sections. One of these contained the ventilation pipe and was used for timber hoisting, while the other served the purposes previously mentioned. Two vertical rows of bracing struts were placed in the compartment at the other end and were so disposed as to give clearance for a small cage which was operated there. A compressed-air whistle was mounted in the ladderway as a means of signaling the men at the face whenever anyone wished to ascend.

The shaft was carried upward in the manner described to a height of fifteen floors, or 120 feet above the opening-out set, where the first of the new levels was to be cut. There a plat or chamber, 15 feet wide, 16 feet long, and having a roof sloping from a height of 13 feet at the shaft to 10 feet at the back, was blasted out at one side. Hitches were then cut in the rock to receive the ends of the collar set which was to support the next 120 feet of timber. This collar set was jointed to the legs of the preceding course, from which the long caps and cross members were removed for use at a higher elevation.

Work on the second level-section began by excavating the shaft to a height of 20 feet and then installing an opening-out set similar to that on the lower level. This was divided into compartments as before, and the spoil chute was equipped with a door through which the material could be directed into the chute below by means of a slide which was channeled through the floor of the plat. The shaft was next raised another floor, after which work was started on the installation of the cage in the winding or hoisting compartment at one end. This cage was designed for the transportation of men and materials between No. 7 and No. 6 levels. Before this was done, the 1-ton air hoist was moved to the higher level by its own power. The rope was wound up until the hook at its loose end reached the pulley suspended at the face, where it fouled; the column on which the hoist was mounted was freed; and the hoist shifted to one end of it. Two 60-foot air hoses, which conveyed air to the drills, were then coupled together and connected to the hoist and to the air main at the lower level. After the air was turned on, the hoist began to wind itself upward, the hose being paid out to follow it. The hoist, with the column attached, was landed at the level above and there set up to serve during the

succeeding lift of 120 feet as it had done on the first lift. At this stage, No. 6 Level was electrically lighted and equipped with a telephone and signal service for communication during the hoist operation.

With the air hoist again installed, the cable from the main hoisting engine was pulled up the winding compartment, passed over a sheave mounted on top of the opening-out set, and drawn down the shaft to the lower level, where it was secured to a cage capable of holding four men. The main-hoist mechanism was an 8x10-inch, double-drum, air-driven unit. One drum carried 1,650 feet of 15/16-inch rope and the other a shorter length of rope that was used as will be described presently. After four courses of timbers, or 28 feet, had been erected, the uppermost sheave was moved to the top of the third course to provide more headroom for hoisting. The manner of doing this is described by Mr. Jakins as follows:

"The spare rope carried on the second drum of the main hoist was pulled to the cage on No. 7 level and shackled to the thimble on the hoisting rope. The cage was then raised to No. 6 level and landed, when the hoisting rope was unshackled from the cage. The spare rope was then used to pull the end of the hoisting rope back to No. 7 level. The portion of the hoisting rope from the hoist up to No. 6 level was clipped at this level and fastened to the shaft timbers. Then the two ropes were unshackled and the free end of the hoisting rope was pulled over the sheave and coiled on No. 6 level.

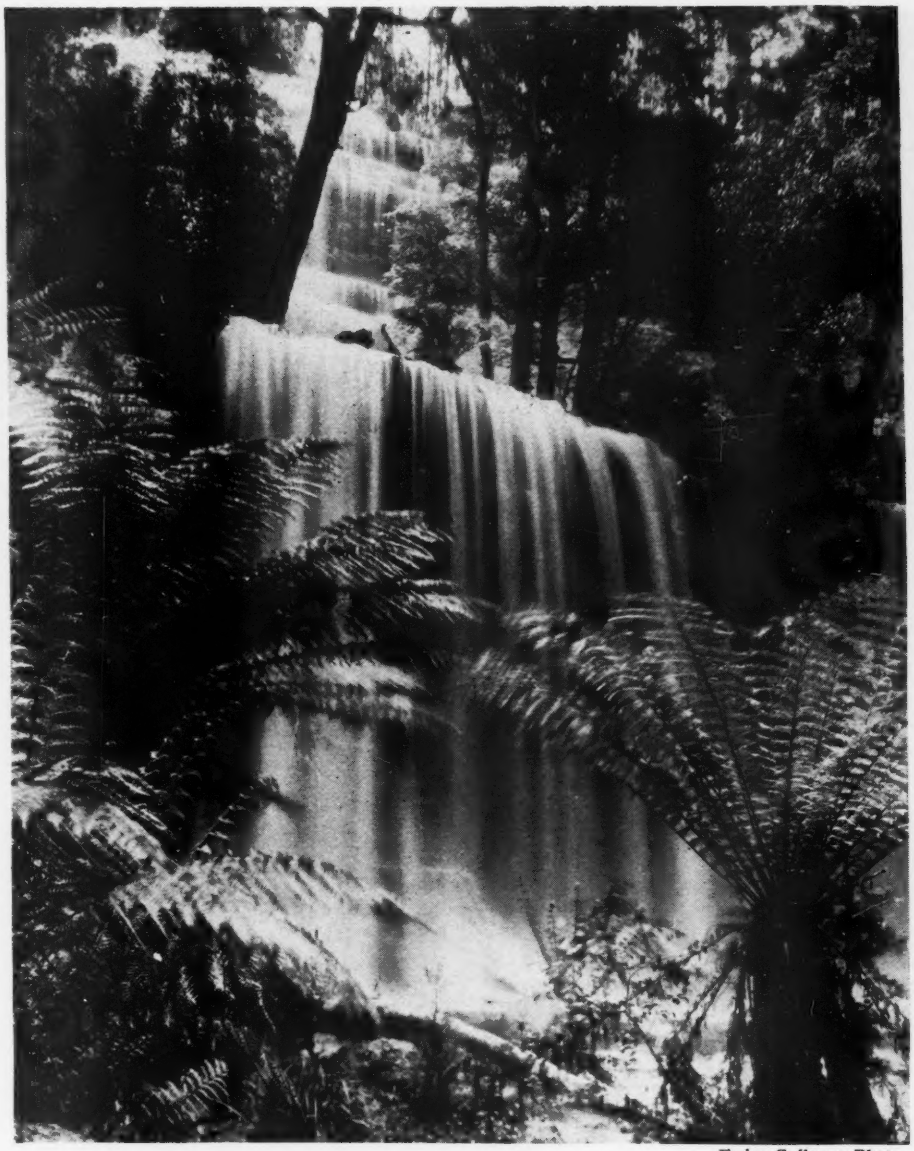
"The 1-ton hoist was then used to lift the sheave and its fittings to their new position. This was done by placing two pulley stulls, one over the ladderway and the other over the winding compartment. After pulleys had been hung to these stulls, the rope was led from the hoist up the ladderway, along the length of the shaft, and down the winding compartment to the sheave. When the latter had been lifted and secured, the hoisting rope was drawn over it and lowered to No. 7 level, where it was again shackled to the spare rope. The hoisting rope was unclipped at No. 6 level and the end hauled back to the cage, to which it was again attached. The last stage was to lower the cage and spare rope to No. 7 level, and wind the latter rope back on its drum.

"When shifting the sheave to higher levels, the two shackled ropes were drawn back only to the level immediately below, and the spare rope hooked on to the shaft timber there while the hoisting rope was being lifted by the small hoist and secured so that it could be placed on the sheave. The spare rope was then similarly raised and shackled to the hoisting rope. This course obviated handling a long length of rope on the plat above."

As the shaft progressed upward toward the surface, the cage was placed in operation to each new level soon after it was opened. Accordingly, the only climbing required of the workmen was in the section under construction. Timber for each floor was hoisted by cage to the nearest level. Supplies of steel and explosives were requisitioned by telephone and likewise delivered to the plat immediately below the face. As a result of this method of handling, the final section from No. 1 Level to the surface was completed with almost the same ease and dispatch as was the first section.

In order to use as much of the spoil as possible in replacing extracted ore, a raise was driven to connect No. 7 Stope with No. 6 Level, and from the top of it a drift was run to No. 6 Plat. Thereafter, all material coming down the chute was trammed on No. 6 Level and distributed to the workings below, instead of being hauled out of the North Lyell Tunnel for disposal. This made it possible to mine 40,000 tons of ore while shaft-rising was underway. After the shaft had reached the surface, considerable development work was done on levels Nos. 4, 3, 2, and 1, and the shaft chute was employed to handle spoil. The shaft was then equipped for permanent use. It was found that the shaft timbers had not been damaged, despite the fact that rocks weighing up to a ton were often sent down the chute. This was attributed to the plan in force, under which the sections of the chute between the various levels were kept substantially full, spoil being drawn down successively from top to bottom as the trammers required it. The entire work was done without any workman incurring a serious injury.

For the facts in the foregoing account and for the quotations included in it, acknowledgment is made to Mr. Jakins and to his paper, *Rising the Royal Tharsis Shaft at Mount Lyell, Tasmania*, which was read before the Australasian Institute of Mining and Metallurgy.

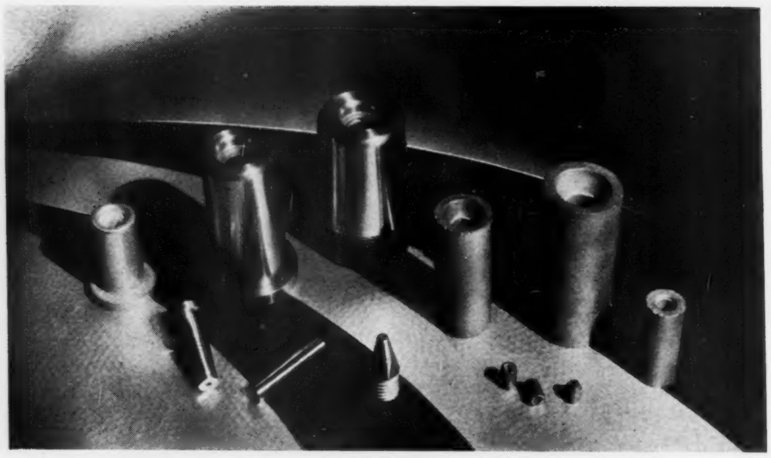


Ewing Galloway Photo

RUSSELL FALLS

Tasmania abounds in picturesque scenery, and in the non-mountainous sections the soil is very fertile. Of late years, the island has become an important fruit producer. The climate is temperate. Tree ferns, which are plentiful in the upland ravines, are shown in this view from the National State Park.

Norbide---
a Real Rival of the Diamond



SAND-BLAST NOZZLES AND LINERS

It is reported that the use of Norbide liners will increase the service life of sand-blast nozzles hundreds or even thousands of times, decrease the air consumption, and improve the over-all efficiency of the apparatus. The manufacturer guarantees such liners for 750 hours of service when using silica-sand abrasive at not more than 90 pounds air pressure. In the picture, nozzles of various sizes are shown at the left and liners for them at the right.

ANCIENT man conjured up a dream stone which he imagined to be so hard that it would endure forever, and he called it adamant. The myth of its existence was soon dispelled; but modern scientists have succeeded in making a material that closely approaches it. It is boron carbide, the hardest artificial substance ever produced, and one that is exceeded among natural materials by the diamond only.

Boron carbide was developed by Norton Company of Worcester, Mass., and announced by Raymond R. Ridgway of its staff. It has been given the trade name Norbide, and is a combination of the rare metal boron and of ordinary carbon such as occurs in coke. It is unaffected by the strongest acids and alkalies, has a compressive strength of 260,000 pounds per square inch, a coefficient of expansion approximately two thirds that of steel, is little affected by temperatures up to 1,832° F.—at which point the diamond burns completely, and is lighter than aluminum.

In the making of the new carbide, the purest medicinal quality of boric acid is taken from the hottest place in the United States where humans live, Death Valley. Into Searles Lake, which is so loaded with crystallizing solids that it has a crust as strong as a layer of ice, holes are drilled, and the saturated brine solution containing boron is pumped up from the lake bed. The extracted boron is shipped to Niagara Falls, where high-temperature electric furnaces convert it into an abrasive.

"The process for converting a material which is mild enough to be used as an antiseptic for the eyes into the hardest-known synthetic material is simple enough when properly controlled," says Mr. Ridgway. "The first step involves the removal of the water of crystallization which accompanies the boric-acid crystals. The removal of this water changes the physical character of the smooth crystals into that of a hard glass slightly harder than ordinary window glass. This anhydrous oxide must be carefully protected to prevent it re-absorbing water from the air and returning to its normal form of boric acid. Carefully weighed quantities of the anhydrous glass are proportioned with the highest grade of petroleum coke, since the inclusion of any ash impurities will destroy the quality and value of the resultant abrasive. In a furnace, which reaches a temperature of approximately 5,000°F., the oxygen is taken from the glass and carbon substituted. At the very high temperature obtainable only in the electric furnace, the carbide melts, and from this melt crystallize beautiful crystals of boron carbide which may serve as an abrasive just as they are taken from the furnace.

"The new material has found an immediate use in the cutting and lapping of the new hard alloys known as cemented tungsten carbides which have replaced high-grade tool steel in many industries. It was not long ago that these carbides were offered as a tool material of such great synthetic hardness that it was difficult to shape them with the ordinary abrasives.

"Experiments have shown boron carbide to be useful for many previously unsuspected purposes. The art of pressure blasting has always been carried on in industry with metal nozzles to control the spray of sand or other abrasive directed against castings and metal surfaces of all kinds. The cleaning of public buildings, the preparation of metal surfaces of automobiles before painting, and the engraving of marble monuments has been carried out for years with the aid of pressure blasting or, as it is more commonly known, sand blasting. To a certain extent the application of hard abrasives to such cutting jobs has been impeded by the high rate of wear on the metal nozzle caused by the abrasive stream through it. The research laboratories of the Norton Company have found that this new carbide is very much harder than the hardest of the old abrasives and that it can be molded into pressure-blast nozzles having many thousand times the wear resistance under blasting conditions of any metal material previously used for this purpose. In some cases one nozzle will last the life of a sand-blast machine, where formerly a nozzle was completely destroyed in thirty minutes.

"Because of the high intrinsic hardness of the product, it was immediately tried on work for which gem materials have been necessary. In this field many successful uses have been discovered. For the drawing of fine wires of all kinds it has heretofore been economical to use large diamonds carefully drilled to produce wire of a definite size by drawing through the opening metal bars of a slightly larger size and by successively reducing the rods until they sometimes became so small that they were finer than the most delicate human hair. This application has been made of the new carbide, and its use has been extended in this field.

"Wear-resistant bearings of all kinds have been manufactured of the new product suitable for inclusion in such widely different apparatus as electric meters and high-speed rotating spindles on grinding machines. Here the high polish and hardness of the boron carbide approaches those obtainable with the highest-grade industrial diamonds. In a certain sense, therefore, we have in boron carbide the industrial diamond obtained by synthetic means.

"It thus appears that as soon as a need develops in industry for a new product, research laboratories set out to find it. The application by the research staff of the du Pont Company of a new means for delustering rayon led to great abrasive wear on the tiny guides that control rayon threads on textile machinery. The ordinary porcelain and even synthetic ruby guides used on weaving and spinning machines deteriorated so rapidly as to endanger the commercial feasibility of the process. The application of boron carbide to the guide surfaces has solved this problem."

The Magicians of Shawinigan Falls

W. M. GOODWIN

CANADA'S ELECTROCHEMICAL CENTER

The community of Shawinigan Falls, Quebec. In the foreground are power plants which can produce 339,000 hp. of energy. The cloud of white fumes near the top marks the site of the calcium-carbide plant of Shawinigan Chemicals Limited, and beneath it are the other buildings of this largest chemical concern in the British Empire. The plant of the Canadian Carborundum Company is also in this area. In the left and lower quarter of the picture are the establishments of the Aluminum Company of Canada and the Belgo pulp and paper mill. The upper view, from an engraving published in 1880 in *Picturesque Canada*, shows the falls as they once looked. The structure at the left is a log chute. Shawinigan Falls is on the St. Maurice River 24 miles above the point where the latter joins the St. Lawrence. The St. Maurice is 400 miles long and, with its tributaries, drains an area of 21,000 square miles.

AN OLD saying tells us that "you can't make a silk purse out of a sow's ear." Achievements much stranger than this, however, are now an everyday occurrence in the realm of modern science and industry. A pair of silk stockings, for instance, is made today from a chip or two of spruce wood, a pinch of salt, a little sulphur, a small lump of limestone, a thimbleful of coal, some air, and a little water, all combined in stages by means of a good deal of electrical energy. Each of these raw materials is required to play its part in the series of syntheses that results finally in the gossamerlike filaments that rival in appearance and usefulness those of the silkworm. And so abundant are the raw materials and so effective the machinery of man's devising that the silkworm, which simply has to chew up the mulberry leaves and let them pass through its body, cannot compete in cost with the complicated factory process of making silk.

This modern alchemy is employed in a wide variety of ways in one of Canada's principal electrochemical districts, Shawinigan Falls, Que. Thirty years ago this was simply a beauty spot in the midst of the unbroken wilderness. Today it is the center of the 1,000,000-hp. St. Maurice River hydro-electric development, a substantial part of the power of which is being converted within the boundaries of the town into many useful products. While much of the power goes out over the high-tension transmission lines that radiate from there to turn the wheels of industry at Montreal, Three Rivers, and a score of other communities, some of it is represented in the outgoing freight on the railways that is consigned to all parts of the world.

Each of the large electrometallurgical and electrochemical industries at Shawinigan Falls has a story that smacks of romance, but the present one will be confined to Shawinigan Chemicals—a "war baby" that has grown up into a robust and vigorous youth with promise of a rather remarkable maturity.

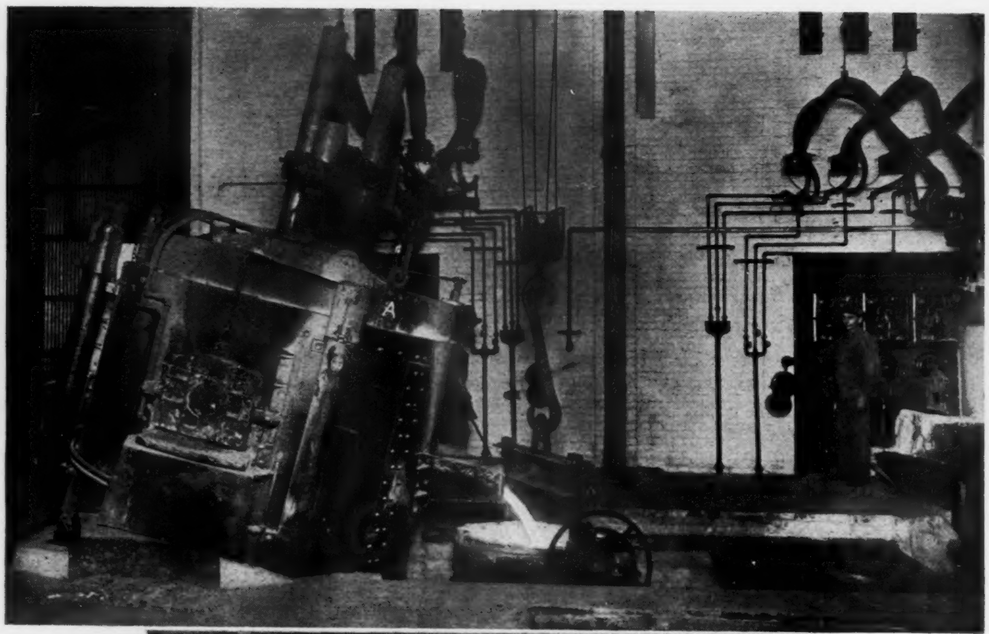
One of the early plants to be established at Shawinigan Falls was that of the Canada Carbide Company, whose product was utilized for making acetylene gas. The plant had a modest output, used largely for the old-fashioned acetylene lighting sets and for miners' lamps. It was in 1915 that the Imperial Munitions Board, faced with a serious shortage of acetone for the manufacture of military explosives, commissioned the Shawinigan company to put into practice certain German patents for making acetone from acetylene.

The patent papers specified a series of syntheses by which acetylene was to be converted into acetaldehyde, the latter into acetic acid, and this, in turn, into acetone; but they did not tell very much about how to effect these transformations without inviting the danger of an explosion. A staff of engineers and chemists set to work to find out; and so successful were they that within six months they had a practical process established on a laboratory scale, and within a year they were turning out acetone by the carload.

At the end of the war the demand for acetone all but vanished, so the management of Shawinigan Chemicals proceeded to create other markets for its products and

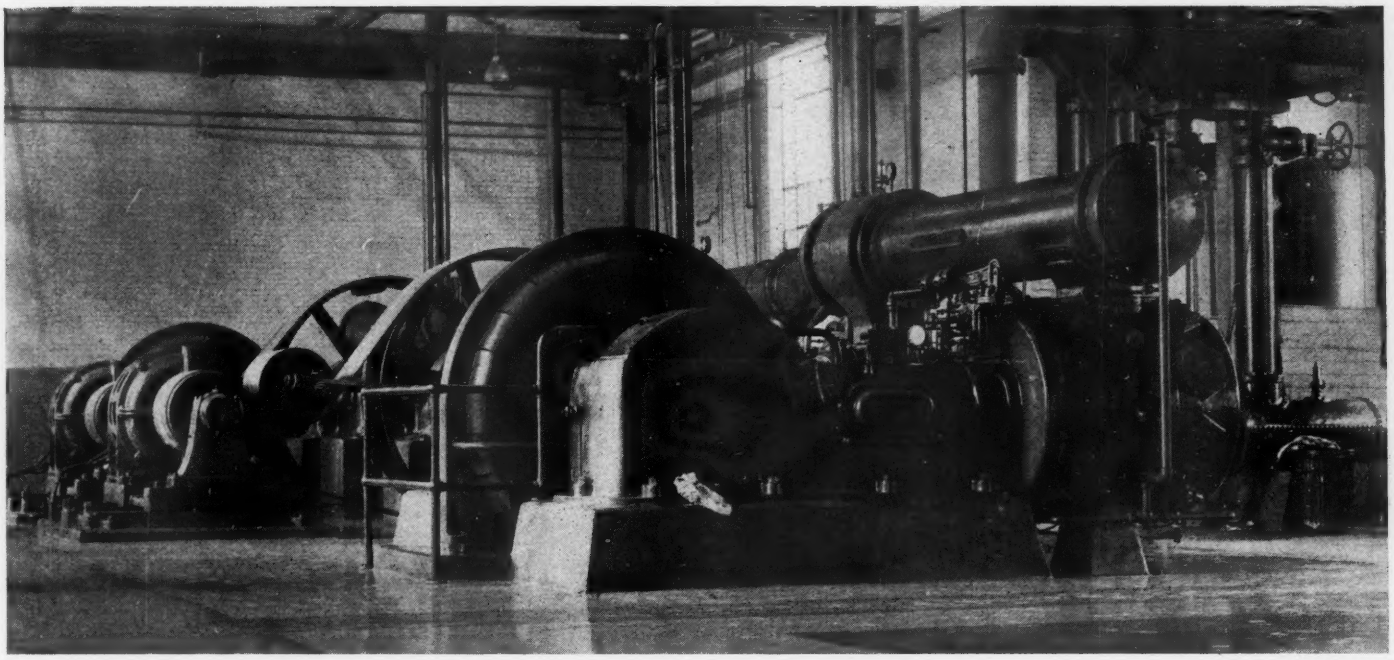
POURING DURIRON

A stainless and heat-resistant alloy steel results from combining iron and silicon in a high-temperature electric furnace. The one shown at the right is of 2 tons capacity. Shawinigan Chemicals Limited makes Duriron equipment for handling dilute sulphuric acid in its acetone process, and also sells castings for use in paper, pulp, and textile mills, chemical plants, explosive works, and for pumps and valves designed for the handling of corrosive mine waters, etc. In the center view, Duriron is being poured from a ladle into a mold. This alloy is amenable to shaping only by casting. Numerous pneumatic tools are employed in this foundry.



SHAWINIGAN CHEMICALS LIMITED

It is here that such commonplace substances as coal, wood, limestone, sulphur, iron, and air are transformed by modern alchemists into scores of useful products whose names are mostly unintelligible to the layman. The original plant made calcium carbide for acetylene lighting systems and miners' lamps. The war metamorphosed it almost over night into a huge acetone factory. Since the armistice, its research experts have been successful in finding peacetime uses for its wartime products and in improving its processes to the point where Shawinigan chemicals can compete with others in almost any part of the world.



AIR COMPRESSORS

In this room are four modern air compressors whose combined piston displacement is 7,436 cfm. The air is compressed to 100 pounds pressure, and is used in the chemical processes, in construction work, and for miscellaneous purposes. These machines, as well as the ammonia compressors in the plant, were built in Canada by the Canadian Ingersoll-Rand Company.

to discover what other useful materials it could make with acetylene gas as a base. This was no easy task, and at times it seemed hopeless. But the company's research men again persisted, and to such good effect that today the chemical plants at Shawinigan far exceed in capacity their wartime maximum. Now they turn out a variety of products that insures a fairly stable market, and the processes have been so improved that those products can meet competition almost anywhere.

Let us take a run through the different plants that have grown up around the original carbide plant within the past twenty years, noting particularly the raw materials and the output of each. It is in the carbide plant itself that the latent energy is stored up that is used to effect many of the subsequent transformations.

Calcium carbide is made by melting together calcined limestone and coke in the intense heat of an electric-arc furnace. The large amount of energy required for this can be gauged from the fact that 20,000 hp. is concentrated and expended in one furnace hearth about 20 feet across. The white-hot carbide is periodically tapped into molds, crushed, and sized for market. The fines and a part of the lumps are converted into acetylene in an adjoining plant for the company's own use.

In the acetylene-gas plant, the gas was formerly manufactured by adding carbide to an excess of water and flushing out the resultant slimy calcium hydrate with still more water. The wet hydrate, a useless product, is no longer made, a marketable substitute being provided instead. In the present process, just enough water is added to the carbide to make the dry hydrate of lime, some of which is briquetted and returned to the carbide furnaces while a part is taken out of the circuit and sold as "chemical lime hydrate" for use in various industries. Thus most of the lime now simply circulates, acting as a vehicle for bringing together carbon from the coke and hydrogen from the water to produce acetylene gas.

The acetylene gas is piped across to the chemical plants, where an amazing series of transformations is effected, the only other substances required being air and water, with an abundance of electrical power. Scores of different chemicals have been built up from acetylene in the laboratory, but only about a dozen are being made in commercial quantities at present.

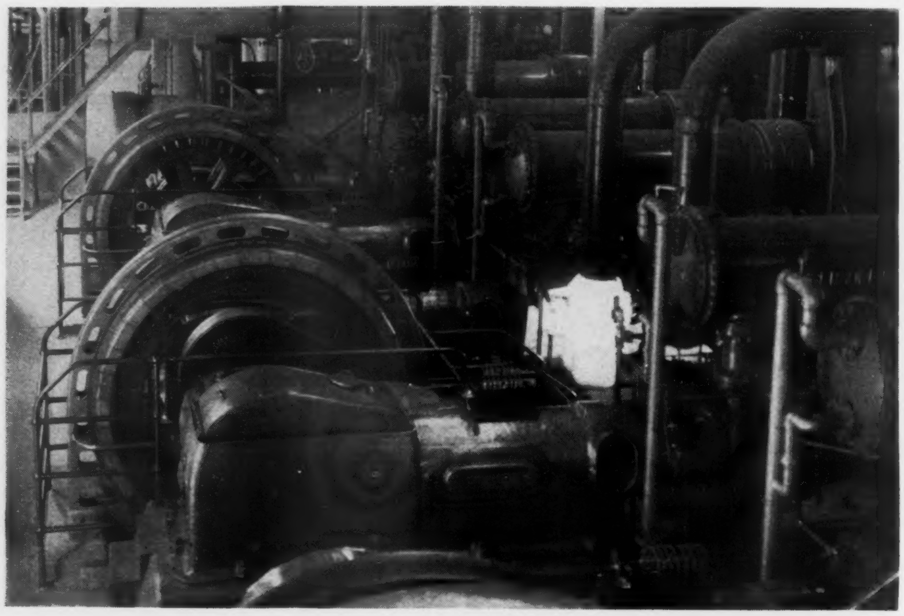
In the Hydration Building the gas is subjected to No. 1 Process, namely, a chemical combination with water. This is effected by passing the gas through hot, dilute sulphuric acid containing mercury salts which act as a catalyst in promoting the union of the gas and the water. This union gives acetaldehyde, a compound chiefly of interest because of its extraordinary chemical activity, which is employed to advantage in the subsequent reactions.

Hot, dilute sulphuric acid is one of the most corrosive liquids in commercial use, and the only known metal that can withstand it is the alloy of silicon and iron, "Duriron." The huge kettles and the various pipes and fittings containing this corrosive solution are, therefore, composed of this expensive alloy. The metal can be made only into castings, and some of these are of large size. This item illustrates the practical difficulties that had to be overcome in order to establish this process commercially.

Acetaldehyde is a colorless liquid with a low boiling point—it boils if held in the palm of the hand. To handle it conveniently, therefore, it must be cooled by refrigeration. As No. 1 Process and those that follow subsequently are exothermic, it is necessary to get rid of the heat thus generated. Consequently, a large refrigerating plant is required, one capable of producing 3,500 tons of ice a day. This is an incidental feature of the plant, but it indicates the scale on which it operates.

The liquid acetaldehyde is piped to the Oxidation Building where No. 2 Process changes it to acetic acid. This is done in a series of 1,000-gallon kettles by blowing air through the liquid under pressure, 30,000 cubic feet of free air per minute being so used. Acetaldehyde combines readily with the oxygen of the air, and the remaining nitrogen is discharged. At some time in the future it is likely that this large volume of pure nitrogen will be put to service. The acetic acid is simply the vinegar of household use in a pure and concentrated form. It has many fields of application, but at present the bulk of it is employed in the manufacture of artificial silk. Some goes to the Malay rubber plantations where the pure acid gives a superior quality of latex, compared with the product obtained by the former crude methods.

Not so long ago, No. 3 Building was devoted to the making of acetone from acetic acid—in fact, prior to the end of the World War the whole plant was given over to its production. The acid was heated and the



REFRIGERATION EQUIPMENT

One of the intermediate products in the making of acetone is acetaldehyde, a liquid which, because of its low boiling point, must be cooled for convenient handling. For this purpose there is installed machinery capable of producing 3,500 tons of refrigeration a day. It is considered to be one of the largest plants of its kind on the North American continent. Some of the ammonia compressors, which are the heart of the system, are shown here. Each of the three machines pictured can handle 3,386 cfm. of ammonia gas, and is driven by a 1,000-hp. synchronous motor.

vapor was passed over a catalyst consisting of a coating of hydrated lime on iron balls. This decomposed the acid, the result being liquid acetone with carbon dioxide and water as by-products. This process, while effective at the time, was wasteful because it turned more than half of the acid into the valueless water and carbon dioxide. Today, acetone is made by more economical methods, and No. 3 Building now houses a completely equipped machine shop capable of doing the large and heavy work required in the maintenance of much of the equipment. Here we have a clear case of "beating swords into ploughs and spears into pruning hooks."

No. 4 Building is the Still House, where the crude acetaldehyde and acetic acid are refined and where the numerous grades of the acid demanded by industry are prepared. This tall building is rather remarkable in appearance inside, resembling somewhat an indoor oil refinery with fractionating columns and stills of great variety. The entire space is surmounted by a traveling crane which can pick up any unit and replace it with the spare that is always ready.

Solvents are made in No. 5 Building, principally ethyl acetate. Two molecules of acetaldehyde are caused to unite by a special procedure to produce this useful solvent, which is employed largely in the manufacture of lacquers. Among the other solvents manufactured by the company at present are butyl acetate and amyl acetate.

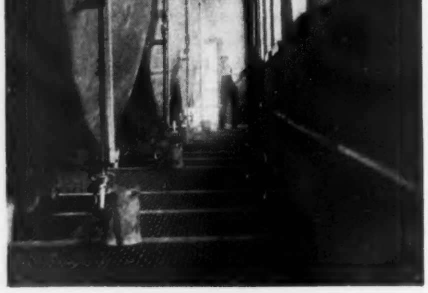
No. 6 Process, the latest to be established at Shawinigan, is carried on in the Gelva plant. When acetylene gas combines with acetic acid there is formed vinyl acetate. This is the basic material for one of the most serviceable of the synthetic resins yet discovered. Vinyl acetate readily polymerizes or condenses to a clear, glasslike solid, and this material, as made by Shawinigan Chemicals, is called Gelva. A modification of Gelva, employing the ever-useful acetaldehyde in a further reaction, is known as Alvar; and if formaldehyde is substituted, a third resin, Formvar, results. These three resins can be made in a wide range of viscosities and softening points applicable to almost any of the uses to which resins may be put—such as varnish bases, molding powder, films, impregnating compounds, insulating materials, chewing gum, etc.

No. 7 is what might be called the plant's service building. It contains, for instance, three 1,000-ton refrigerating machines, three large air compressors, the pumps required for circulating the calcium-chloride brine used as a refrigerant, and the pumps for the substantial flow of cooling water drawn from the St. Maurice River and returned to it again—the equal of a good-sized brook. Electric-steam boilers using surplus power, which is a great deal cheaper than coal for making steam, is a feature of this plant.

There is another process that has recently attained considerable commercial importance and that is a convenience to the series of chemical plants described by reason of the fact that it consumes any excess of acetylene gas that may be available, thus acting as a balancer for the system. This is the Shawinigan Black Plant where, by very simple means, the carbon of the acetylene is liberated as carbon black of unique quality. The decomposition of the gas is quantitative, so there is no waste of gas as is otherwise the case. Shawinigan Black is quite different in its physical properties from the carbon black made by other methods, having, for instance, a higher electrical conductivity which is of advantage when it is used in dry cells and for similar purposes.

These are the principal products of Shawinigan Chemicals and the plant that builds them up out of coal, limestone, air, and water. Besides, there are numerous chemicals which occur as by-products of the main reactions. Some of these are mere laboratory curiosities at present, but uses have already been found for others which are being marketed, and research is continually adding to the latter. Their names sound like a page from a Greek dictionary, a few of the more common ones being: acetonylacetone, dimethyl furane, dihydroparatolualdehyde, terephthalic acid, 1.3 butylene glycol diacetate, croton aldehyde, and crotonic acid. These, and many others with still more unutterable names, are old friends to the Shawinigan chemists.

While the raw materials for all these chemicals are, as previously stated, coal, limestone, air, and water, the useful chemicals resulting are organic compounds of many and increasing kinds. As with a living organism, the plant of Shawinigan Chemicals is capable of a growth and of a diversity of functions such as but few industrial enterprises can command. Its products can be changed to suit the changing times; and to their number there is apparently no end.



STORAGE FOR CHEMICALS

Four of the ten tanks in this building that provide storage capacity for 2,000,000 pounds of chemicals. The tanks are made of aluminum, and each is 10 feet in diameter and 40 feet long.

CARTAGENA HARBOR SCENE
The profusion of small craft of varied kinds that plies the waters is evident in this view. The harbor is not only spacious but also protected from ocean-born storms by a large island, Tierra Bomba.

The New Port of Cartagena

Extensive Improvements of Colombia's Ancient Maritime Stronghold Increase Her Importance in World Trade

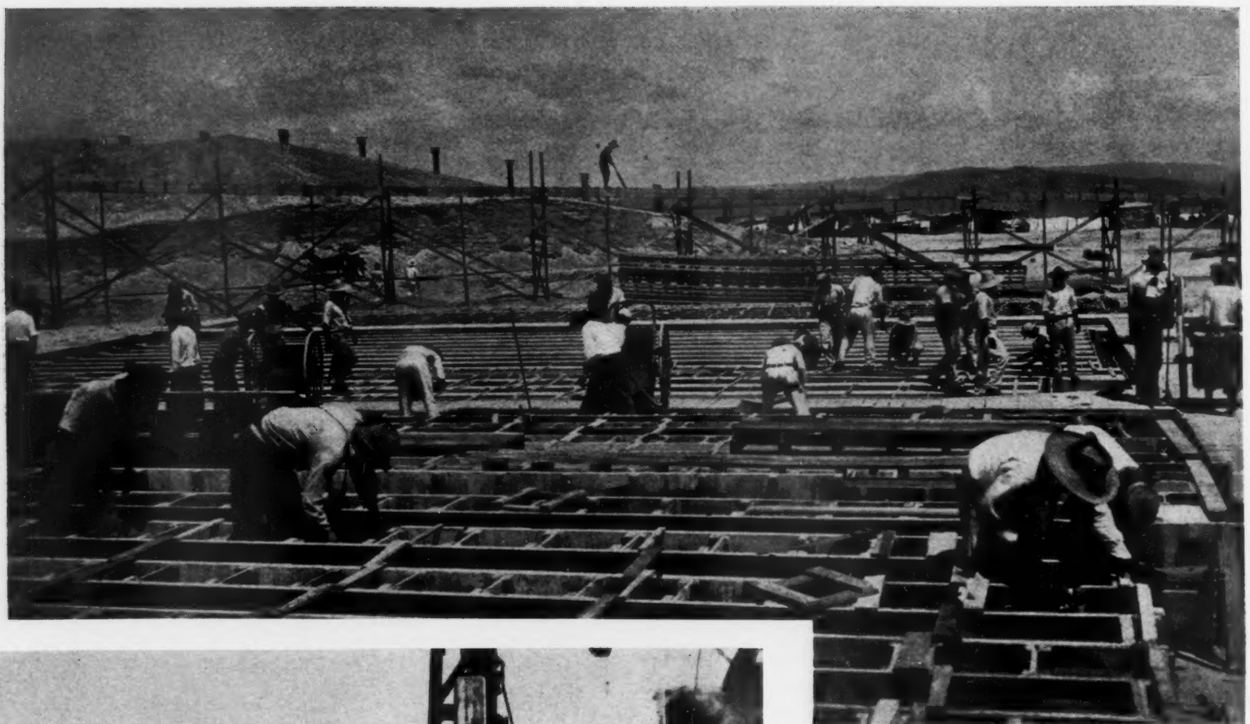
ROBERT G. SKERRETT

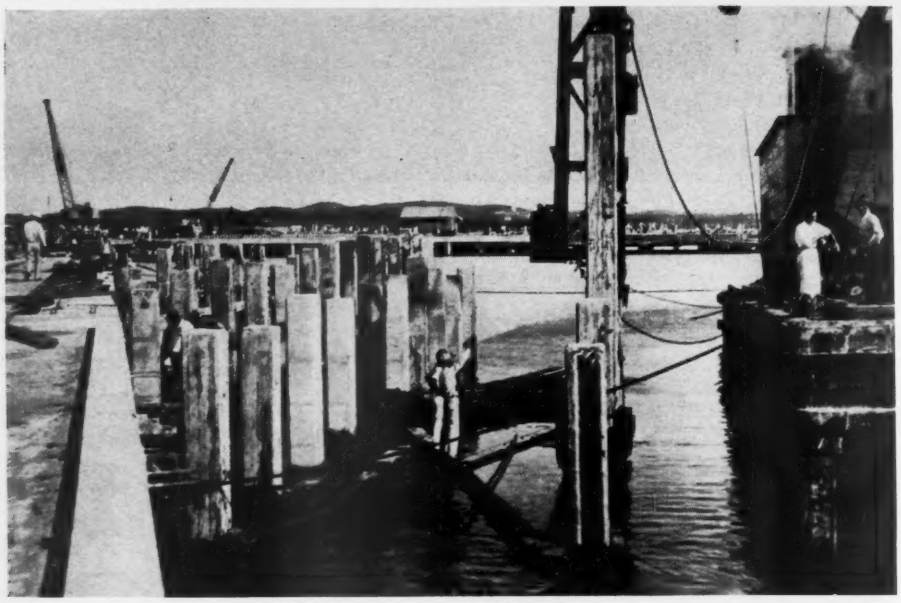
CARTAGENA, one of the oldest of Colombia's seaboard cities, has recently commemorated the four-hundredth anniversary of her founding by Pedro de Heredia. At the same time, Cartagena celebrated the completion of certain harbor works that give the port a revived importance in the promotion of Colombia's foreign commerce. American engineers and constructors, in collaboration with the energetic Colombian government, have been instrumental in making Cartagena better able to serve the country's vast hinterland which abounds in natural riches.

Cartagena, thus equipped with modern facilities wherewith to reclaim her erstwhile maritime preëminence in that part of the Caribbean Sea, reminds us afresh of those glamorous days when she enjoyed the proud status of the principal port and stronghold of Spanish America. Strange as it may seem, it is nevertheless a fact that some of the means adopted nearly two centuries ago to safeguard Cartagena from hostile approach from the sea ultimately crippled her in the race for world trade.

For generations following the founding of Cartagena, in 1533, galleons laden with colonists and Spanish goods arrived at Cartagena twice yearly; and, likewise every six months, the ships that had brought silks, satins, fineries of all sorts, and many other luxuries and essentials from Europe, carried back with them heavy cargoes of rare woods, emeralds, gold, and other precious gems and minerals. Cartagena flourished while the coffers of Old Spain were filled from the treasureland which Columbus had made known to his royal patrons. It was inevitable that other nations should look with covetous eyes upon Cartagena, and it was equally inescapable that the buccaneers of the Spanish Main should lie in wait for the richly laden galleons and even attack and sack that favored seaport. Indeed, Cartagena was so ravaged by pirates from time to time that Spain, in the eighteenth century, erected a formidable array of masonry defenses there and armed them with cannon of ample power and in sufficient numbers to hold them at a safe distance. These fortifications cost Spain more than $60,000,000 in gold; and with those walls and guns Cartagena was able to resist the attack made by the British under Admiral Vernon in 1741. Many of the old defenses are still standing: their last test came in 1815, during the War of Independence, when the city held out for four months against the besieging Spanish forces and surrendered only when well-nigh all the defending soldiers and the majority of the civilian populace had perished. It was that gallant resistance that won for Cartagena the title of "The Heroic City."

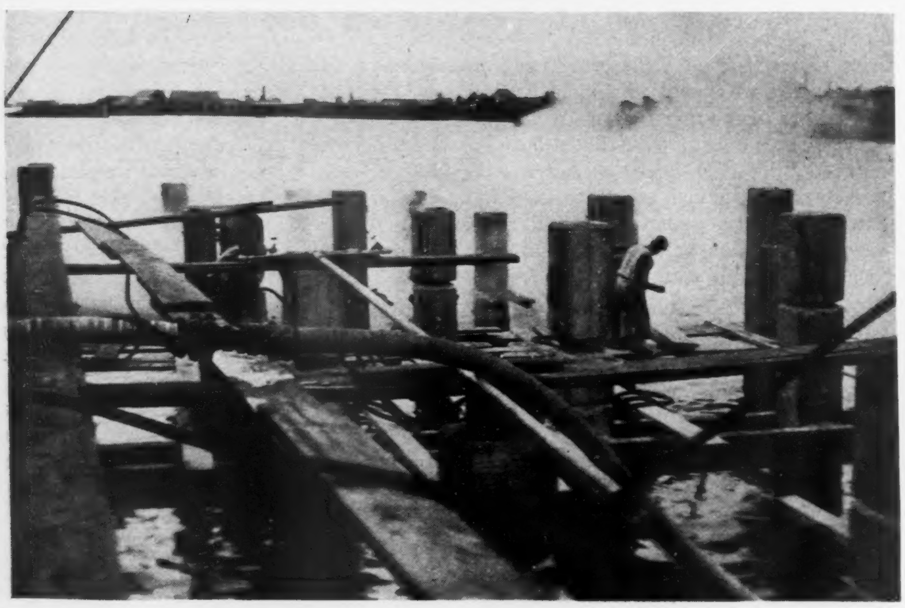
Cartagena can justly claim to have one





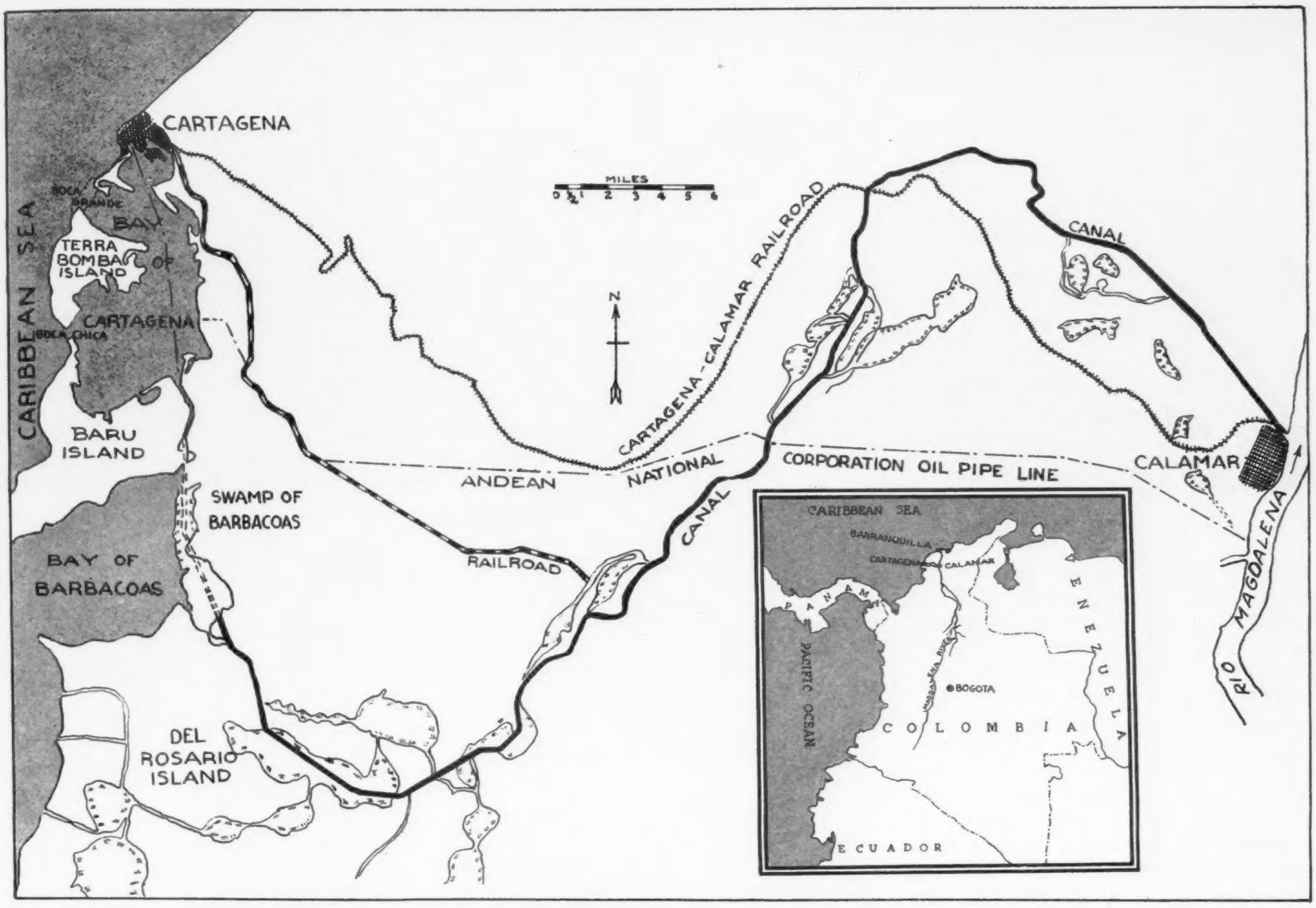
PILES FOR HARBOR WORKS

These pictures show the sequence of casting and driving the reinforced-concrete piles which support the new piers and bulkhead. These piles are from 55 to 70 feet long and were driven to refusal by 5-ton hammers. After they were in place, those that extended above grade were cut off by means of air-operated chipping hammers.



of the most spacious and beautiful of harbors. From north to south the Bay of Cartagena is 14⅓ miles long, and it has a maximum width of more than 5¼ miles. Its midlength is protected from the sweep of the open ocean by a large island known as Tierra Bomba. A wide opening north of the island—Boca Grande—was for many years the easiest and shortest passage in and out of the harbor. South of Tierra Bomba nature provided a narrower, winding channel in and out of the bay. That passage, known as Boca Chica, is about nine miles to the south of Cartagena. The better to protect the city from hostile craft, the Spanish Government, in the eighteenth century, closed Boca Grande to navigation by blocking that channel with obstructing rock, placed there at great cost and much labor, and built heavy fortifications on both flanks of the tortuous Boca Chica.

These various defenses served their primary purposes; and the longer approach to the port via Boca Chica did not seriously interfere with trade in the leisurely days of sailing ships—especially prior to 1831 when Colombia, then designated New Granada, was established within her present territorial limits. But there came a day when time did count in competing for maritime business, and Cartagena suffered by being less accessible to merchant craft than some



GENERAL LOCATION MAPS

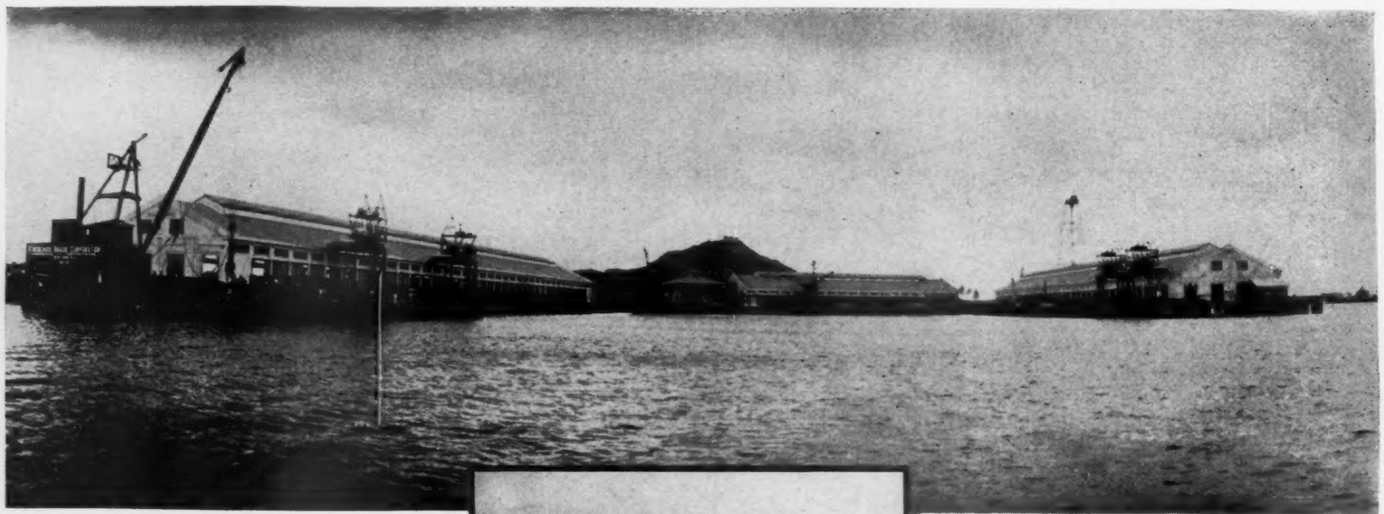
The larger sketch shows the importance of the Port of Cartagena by virtue of the 87-mile canal which links it with the Magdalena River. Barranquilla, at the mouth of the river, has no direct connection with the open sea because its harbor entrance is blocked by a bar which has defied removal. Accordingly, ship-borne goods bound to or from the interior must either be transshipped seventeen miles by rail to or from Puerto Colombia or take the canal route via Cartagena. The Magdalena extends for 1,000 miles into the interior and is navigable to sizable ships for about half that distance. Colombia, fourth in size among the South American countries, has an area a little greater than that of the combined states of Texas, Arizona, and Oklahoma.

other seaboard cities a few tens of miles away. Not only that, but before 1891 ocean-going vessels had to unload and load by means of lighters, and there were no wharves at which they could tie up to facilitate the transfer of freight. That situation inevitably added considerably to the cost of handling imports and exports. This has been especially true of commodities originating beyond Cartagena or destined for points in the interior of the country. Thus the city, originally favored by nature for development as a great *entrepôt*, was hampered by the closing of Boca Grande and was eventually outstripped by Barranquilla, even though that port, which has to make use of Puerto Colombia, does not possess the physical advantages of a landlocked harbor such as has Cartagena.

The Magdalena River is Colombia's great artery for water-borne transportation to and from the Atlantic Coast. It reaches far into the rugged interior of the country which, because of its heavy grades, has made the construction of railroads difficult and their operation expensive. Steamers of fully 500 tons run between Barranquilla and La Dorada—a trip of 514 miles; and by that route the major volume of Colombia's exports and imports is moved. Although Barranquilla is on the Magdalena and near its mouth, still vessels cannot enter that port from the sea. Navigation is blocked by a bar at the river's mouth; and up to the present time that barrier has defied all efforts to open and to maintain a channel for shipping. Outbound cargo arriving by river craft must either be discharged at Barranquilla and transshipped by rail to Puerto Colombia, seventeen miles away on the coast, or be diverted to Cartagena, 50-odd miles away. This procedure is reversed in the case of imports. On the other hand, Cartagena is connected with Calamar, on the Magdalena, by rail and by canal. The latter is known as "El Dique," and was originally developed by the Spaniards. It has long linked Calamar with Barbacoas Bay, which immediately adjoins Cartagena Bay.

El Dique traces its course for a distance of about 87 miles through a succession of swamps and lakes which, to a considerable extent, have provided a natural channel that is navigable to only rather small boats and, therefore, of but little value as a means of transporting bulky freight. Since 1923, however, much work has been done on the canal to convert it into a really important water route for commerce. Within the past two years its usefulness has been tremendously increased by the excavating of Barbacoas Cut. This cut is seven miles long and provides a sheltered route for canal boats which previously had to cross a stretch of open water directly exposed to the sea. Not infrequently traffic was halted until wind and waves subsided. The new cut by-passes Barbacoas Bay and extends through swamp lands between the sheltering islands of Baru and Rosario. The minimum depth is now 11½ feet, and this is sufficient for use by decidedly sizable river craft.

In order that we may fully realize what has been done at Cartagena to make the port a truly modern one, it should be recalled that prior to 1891 Cartagena did not have a single pier at which a seagoing ship could be moored. During that year a wooden wharf, known as "La Machina," was built and provided with a rail connection. That made it possible to load and unload directly without employing lighters, as had



THE HARBOR IMPROVEMENTS

At the left and right, top picture, are the two new piers, each 600 feet long and 130 feet wide. In the center, just inshore from the bulkhead, are the administration building and the central warehouse. El Dique, the canal that joins Cartagena with the Magdalena River, has been dredged recently to a minimum depth of 11½ feet, thus permitting its use by fairly large river boats. Throughout much of its course the canal traverses inland lakes and swamps. A section of it is shown in the lower view.

previously been necessary. La Machina helped Cartagena immediately, and also enabled the port to do a certain amount of business in the general foreign trade of the republic. Unfortunately, the wharf was swept by fire in 1930, and for all practical purposes destroyed. Thereafter, goods had to be transshipped by lighters, and this both slowed up and added substantially to the cost of handling inbound and outbound freight. Now for the transformation that has been wrought since April 28, 1932.

Recognizing the strategic location of the port, and with a full grasp of the present and potential importance of Cartagena to the economic development of the entire nation, the Government of Colombia, through President Enrique Olaya Herrera and the Minister of Public Works, Alfonso Araujo, decided to reconstruct the harbor along modern lines. The Frederick Snare Corporation, contracting engineers of New York City, was selected to investigate the problem and to design facilities that would best meet existing and future needs; and to this same experienced organization was later entrusted the work of virtually creating a new port in accordance with the plans submitted by that company after they had been carefully checked and approved by Dr. Germán Uribe Hoyos, former Minister of Public Works and recognized as one of Colombia's most illustrious engineers. Construction was started in May, 1932, and carried forward with such expedition that the project was an accomplished fact and ready for service on November 1, 1933.

The waterfront is now made secure by a concrete bulkhead, 33 feet wide and 1,065 feet long, from which extend out into the harbor two reinforced-concrete piers each 130 feet wide and 600 feet long. For the storage and the inspection of cargo, each of these piers carries a steel shed equipped with a complete system of fire protection, including pressure tanks, automatic pumps, and alarm stations. There are two electric cargo cranes on each pier for loading and unloading river craft and lighters, and on the bulkhead are other cranes—one of which has a capacity of 15 tons for heavy lifts. A 20-ton floating derrick, tugs, lighters, conveyors, piling and stacking machines, and other apparatus and equipment are provided to round out the port's facilities. Rail connections are made with the Cartagena-Calamar Railway and with the Central Bolivar Railway, the tracks running out on the piers for either direct loading or the transshipment of freight. Just inshore of the waterfront bulkhead is a third storage shed and an administration building of ample capacity.

The space between the two piers is substantially 400 feet wide. One of the slips and its entrance channel have been dredged to a minimum depth of 39 feet below low tide, and this assures sufficient water alongside the piers for the accommodation of the largest steamers. The other slips have been cleared to 33 feet at low tide. The material that has been dredged from the harbor bed has been deposited between the concrete bulkhead and the old shore line; and in this manner has been built up 23 acres of land for the arrangement of track connections and for storage purposes.

The excavating of the Barbacoas Cut, the improvement of El Dique, and the deepening of the harbor channel and the slips on both sides of the new piers have been done by a dredge that has well demonstrated her seaworthiness by traversing long stretches of open ocean. This vessel was towed 3,500 miles from the Port of New York to Callao, Peru, and had just completed her work in Callao when the Frederick Snare Corporation was awarded the contract for the betterment of the Port of Cartagena. Accordingly, she voyaged northward along the Pacific Coast of South America and again through the Panama Canal to reach her new scene of operations. In deepening the harbor, in digging the cut, and in improving the canal, the Frederick Snare Corporation has dredged all told 2,500,000 cubic yards of material. To make Boca Chica better suited to present-day requirements, that naturally narrow and winding waterway was dredged a few years ago to a depth of 40 feet, and the channel is now 500 feet wide and straight.

In order to carry on the work in an efficient manner, the Frederick Snare Corporation had to create a camp for a large number of its employees and to erect a suitable plant for the washing and the screening of sand and gravel for concrete. Furthermore, an area had to be set aside and properly equipped for the casting of some thousands of reinforced-concrete piles that support the piers and the waterfront bulkhead. The piles are rectangular in cross section, measure 18x18 inches, and vary in length from 55 feet to 70 feet. They were driven to refusal in the underlying hardpan with 5-ton Vulcan steam hammers. As many as

REMINDERS OF FORMER DAYS

During colonial times, Spain spent more than $60,000,000 at Cartagena erecting fortifications so as to repel the pirates that infested the Caribbean waters. At the top is a section of the old wall, La Bovedas. Cells within that structure of defense were filled with patriots during the War of Independence. It is antedated by the Fortress San Fernando, built in 1759 to resist attacking fleets of enemy nations. A portion of that bulwark is still standing and is shown in the lower picture.

600 piles were cast in the course of a month; and at the peak of activities, 700 were sunk in 30 days. After casting, the piles were seasoned for a suitable period before driving.

While operations at Cartagena did not call for the excavating of ledge rock—although the contractor had air-driven drills available for that purpose, nevertheless compressed air was variously and frequently used. For example, the reinforced-concrete piles were often overlong, and the excess projecting above water or the beach after placing was cut off with chipping hammers. Similarly, concrete in various locations had to be trimmed and drilled to make prescribed adjustments or to install apparatus and fittings of different kinds, and woodborers and other labor-lightening pneumatic tools were employed in preparing timber for a multiplicity of services. All this equipment was of Ingersoll-Rand make, as were the portable compressors. At the climax of the work, a force of 500 men was on the job.

Under the contract, the Frederick Snare Corporation was obligated to complete the undertaking within 24 months from the start of operations; but by reason of the coördination of the work and the energy displayed at all times, the task was finished within the remarkably short span of eighteen months. Because of this expedition, the new facilities of the Port of Cartagena were ready for service and yielding revenue six months sooner than expected. The contract was for a lump sum of $2,850,000—the ultimate capital necessary for carrying out the project being contributed jointly by the Colombian Government, the Andean National Corporation, and the Frederick Snare Corporation. It is reasonable to assume that the new port facilities will produce a substantial increase in revenue, thus making the undertaking self-liquidating and in no wise a burden on the federal treasury. With the greatly improved service now at the disposal of shipping, and at lower rates than have heretofore prevailed at Cartagena, that port should recover its erstwhile maritime position. Colombia's commerce with the world at large has been steadily mounting in latter years.

For those who may not have a clear conception of Colombia's geographical features, let us remind them that that republic has nearly 500,000 square miles of land on which can be raised well-nigh all the products of the world. A similar area in the United States would embrace our Atlantic seaboard states from Maine to Florida, with the addition of Ohio and West Virginia. Colombia is the third largest country in South America. Even though lying within the tropic zone, she has a range of climate extending from that of torrid jungles to that of perpetually snow-clad mountains. She is especially rich and varied in her horticultural abundance, being first in the production of mild coffee and third in the growing of bananas. She is the greatest source of emeralds, ranks second in the output of platinum, and her mines exceed those of any other South American nation in the production of gold. Colombia promises to be one of the world's most important sources of petroleum. In 1932, her oil output amounted to 16,414,000 barrels, and her exports totaled 15,320,000 barrels valued at $16,437,783. A pipe line 335 miles long, owned and operated by the Andean National Corporation, runs from the interior of Colombia to Cartagena Bay. It has a daily capacity of 50,000 barrels.

Within her forests, besides such timber as cedar, mahogany, balsa wood, lignumvitae, etc., are to be found medicinal barks, balsams, gums, rubber, chicle, ivory nuts, tanbark, and numerous other valuable commodities; and upon her expansive grazing lands there are about 7,500,000 head of cattle. In addition to the minerals already mentioned, Colombia has great deposits of silver, copper, iron, tin, cinnabar, lead, nickel, coal, and asbestos. Indeed, Colombia is just coming into her own in the development of her resources and in winning her logical share of world trade; and the outlook for Cartagena, with her modernized port facilities and readiness for the demands that will inevitably come, is in truth a very encouraging one. Already, this historic city is feeling and responding to the urge of the times. Even so recently as 1912 her population did not exceed 36,000. Six years later, her people numbered 51,000. Today she has within her limits a population of nearly 93,000.

As she stands today, Cartagena commingles in a fascinating way picturesque evidence of the centuries gone and those tokens that mark the intervening march of progress. To the tourist, Cartagena and Colombia generally should and will undoubtedly make a strong appeal. In that veritable "Treasure Land," where Old Spain still lives in many ways, one follows in the footsteps of Columbus and the conquistadors.

CEMENT BY PRESCRIPTION

BY THE use of a patented process developed by C. H. Breerwood, vice-president of the Valley Forge Cement Company of West Conshohocken, Pa., it is now possible to manufacture cement of a definite chemical composition. These results are obtained by grinding the raw materials, separating them, and recombining them in the exact proportions desired. The process is now in use on a production basis, and the savings which it effects are reported to more than offset the increased costs entailed.

Because of minor variations in raw materials, no two cement-mill clinkers are alike, and the product of one mill may change perceptibly from day to day. Fairly close control can be exerted over the finished cement by adding to the raw mix additional quantities of any constituent in which it may be deficient; but precisely proportioned mixtures have hitherto been unobtainable, save in the laboratory. This variation can be and is overcome to some extent by blending the product of many days' run. However, the method put forward by Mr. Breerwood makes blending unnecessary and enables the chemist to ascertain in advance just what kind of cement he is going to produce.

The Breerwood process enlists methods and machines that have long been used in treating ores. Briefly stated, it consists of classifying and segregating the various constituent minerals of the raw mix. Either wet- or dry-type separators may be employed in conjunction with froth flotation units. Details of the treatment must be altered according to the composition of the raw materials, but tests conducted at the Valley Forge plant with cement rocks from different parts of the world indicate that all are susceptible to handling in the new manner. It also appears that, by selecting the appropriate flow sheet in each case, grinding costs can be materially decreased and a uniform product of definite and determinable chemical make-up turned out at the same time.

NOTABLE CAREER CLOSES

THE DEATH on November 3 of Sir Robert McAlpine at the age of 87 years removes one of England's most outstanding constructional engineers and builders. His life story reads like a romance. He began his career as a doer of odd jobs in a coal mine when he was fifteen years old. Yet he founded a great company and executed during the next half-century engineering contracts valued at $500,000,000.

Among the almost countless projects which he carried to completion were the Wembley Exhibition Buildings, the $15,000,000 Tilbury Docks, the palatial Dorchester Hotel in Park Lane, London, the Spondon factories and housing schemes of the British Celanese Company near Derby, and the vast Singer factory at Clydebank.

Much of his success arose from his readiness to try new methods and materials. He was a pioneer in the use of compressed air and reinforced concrete; and such was his fondness for the latter material that he has been buried in a finely wrought concrete mausoleum designed and built under his personal direction some years ago.

Thirty-eight members of the McAlpine family, including Sir Robert's sons are now active in the firm which bears his name. His sons share alike in the business, their father having decreed that they shall be either equally poor or equally wealthy.

OUR COVER PICTURE

THIS striking underground mining view shows an Eimco-Finlay loader working in a stope of the Lakeview & Star Mining Company in Australia. Details of this loader, which is made by the Eastern Mining & Metal Company of Salt Lake City, Utah, were given in our February, 1933, issue. Its operating power is supplied by two 5½-hp. compressed-air motors.

BIRTHDAY FELICITATIONS

IN THE spring of 1884, J. R. Marks and "Billy" Hart quit their placer diggings in Buckskin Gulch, Idaho, located a lot in the Town of Murray, and erected thereon a 25x40-foot frame building. Upon its front they nailed the sign: "J. R. Marks & Co.—Hardware Merchants." A little later they took in E. H. Moffatt as a partner and opened branch stores at Wardner, Burke, Mullan, and Wallace. Subsequently, four of these establishments were sold, and efforts were concentrated on the Wallace store.

In 1891, Dr. T. G. Heine of Phillipsburg, Mont., decided that the Coeur d'Alenes needed a foundry, and he proceeded to provide one at Wallace, the equipment being shipped in over the shiny new rails of the Northern Pacific Railroad. Drawings or measurements of the machinery in use at the lead-silver mines were secured and patterns prepared from them. Coke and pig iron were imported from Pennsylvania and, in 1892, the foundry started operating.

The two concerns thus born, eventually were merged into the Coeur d'Alene Hardware & Foundry Company, which is today the largest industrial firm in Idaho. In attaining the ripe old age of 50 years in a new country, the company experienced many ups and downs. Three times fires wiped out one of its component concerns lock, stock, and barrel, but a new and better building arose each time.

Mining men throughout the West know the firm and its products. It makes many things which are vital to the mining and milling of ores. Its crowning achievement was the manufacture of the 800-hp. hoist which raises all the ore of the Bunker Hill Mine, one of the nation's greatest lead producers. It is the foremost "trouble doctor" of its section, and prides itself on the speed with which it can duplicate a broken part of a machine essential to putting some unfortunate mine or mill back into production.

HANDY PORTABLE CLEANER FOR COMPRESSED AIR

IN CLEANING the inner works of motors, generators, switchboards, engines, etc., with jets of compressed air it is important that the air be free from oil, moisture, and dirt if it is not to defeat its own purpose. In other words, if they are not removed it simply means blowing the accumulated dirt from commutators, brushes, switch points, polished bearing surfaces, etc., and leaving in its stead impurities that may be more harmful than the original deposit. With this in mind, the Hagan Corporation, Pittsburgh, Pa., has developed a portable compressed-air cleaner that can be wheeled easily to the point of application—the only point, as the manufacturer stresses, where it is possible to remove from the air all the entrained foreign matter.

The new air cleaner, as the accompanying illustration shows, consists of a tank—a section of standard 8-inch pipe—with semisteel heads held in place by ¾-inch through bolts. Mounted in the upper part of this tank is a Hagan centrifugal separator of the type used on the U. S. Dirigible *Macon* and built under rigid U. S. Navy specifications. All impurities removed from the air in its passage through the separator are retained in the tank, which is provided with a gauge glass so that the operator may know at a glance when it requires draining. This can be done quickly by turning a valve at the bottom of the tank. On opposite sides of the cleaner are hose racks carrying, combined, 50 feet of

air hose—25 on the air-inlet side and 25 on the discharge side. The latter terminates in a pistol-type valve nozzle.

The Hagan air cleaner is as easy to handle as a vacuum cleaner; can be attached to any air outlet; and is always ready for service. It was designed especially for power houses where there is a concentration of the aforementioned equipment, but can, of course, be used anywhere where compressed air is available and where that medium alone can be counted upon to reach the inaccessible parts of machinery and to remove the dirt which, if permitted to accumulate, would reduce their operating efficiency.

COMPRESSED AIR OF SERVICE IN BUILDING LIGHTNING ARRESTERS

POWER-STATION lightning arresters are heavily taxed and must be proof against moisture, which is their worst enemy. Elaborate precautions are therefore exercised in their construction so that they will be effectually sealed and able to perform their dual function of reducing surge voltages to values that will not harm the apparatus being protected and of acting as insulators after the surge has been discharged.

Station arresters consist essentially of two parts: the gap and the arrester elements. The gap is a completely insulated structure in a porcelain casing which is tested for tightness with compressed air before the gap elements are inserted, whereupon the unit as a whole is submerged in water and subjected to high-pressure air—leakage being indicated by escaping air bubbles. This is followed by a special dry-air treatment, after which the assembly is filled with air dried and tested for dew point at −58°F The latter measures are taken in order to prevent internal condensation.

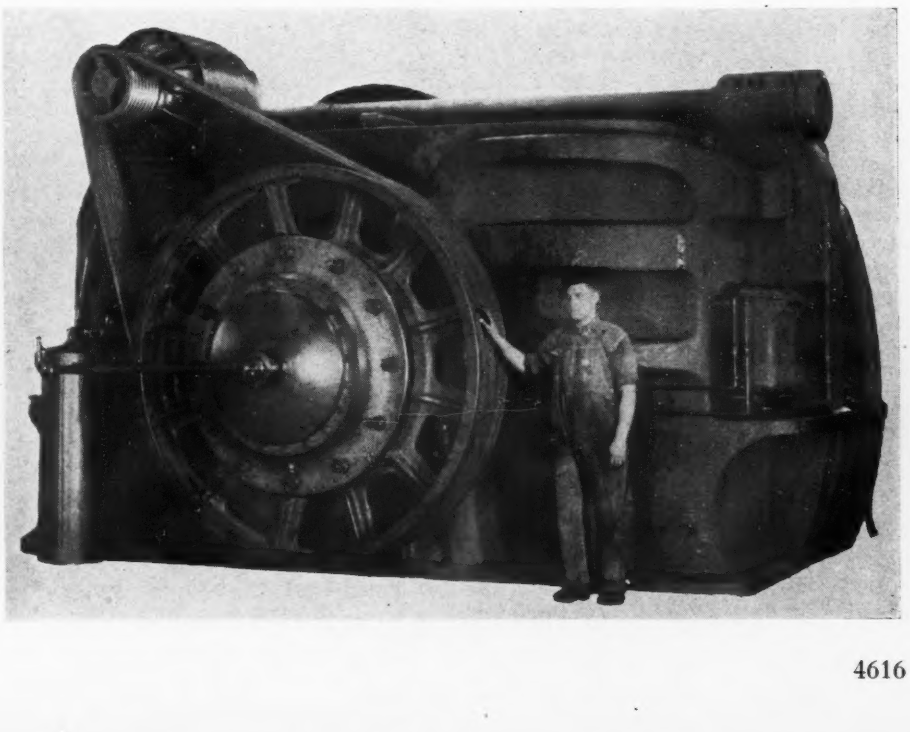
The arrester elements are also encased in porcelain and, although they are not as susceptible to moisture as the gap elements, they are carefully sealed and each unit given the same routine pressure test. The finished product, as can be appreciated, is as waterproof as it is possible to make it, with the result that it can be depended upon to rob lightning of its destructive power.

AIR CLUTCH FOR HEAVY-DUTY FORGING MACHINE

FOR starting and stopping its heavy-duty forging machines, National Machinery Company, Tiffin, Ohio, offers a new and simplified type of air clutch as alternate equipment for the quadruple-abutment clutch. While the latter is highly efficient, the pneumatic clutch eliminates the noise caused by the pick-up when the clutch block engages the abutment in the gear.

Pressure is applied to the friction disks by a large-diameter air plunger which forces the plates together quickly, thereby avoiding the heating that is experienced with a clutch that operates slowly. Multiple disks of unusually large area are employed to hold down the unit pressure and to maintain a low temperature even when they are tripped at frequent intervals. When the pressure is released, compression springs both expel the used air and separate the plates to reduce wear and to prevent heating. A small amount of low-pressure air is required to operate the clutch effectively.

In combination with the air clutch is employed a so-called "friction-slip relief." This is a separate safety unit and serves to relieve overloads on the machine. This makes it possible to use a large-capacity, oversize air clutch and one that does not have to act both as a driving medium and a slip relief, as is generally the case. Air clutches of this type are being built in a full range of sizes and for other purposes where great driving torque and fast operation are demanded. The accompanying photograph of a 6-inch National forging machine shows the generous proportions of the clutch.



Industrial Notes

Paints containing powdered cork are especially well suited for the coating of surfaces that should be protected against rust and corrosion or insulated against heat and sound.

The Goodyear Tire & Rubber Company, in coöperation with the Department of Parks of Akron, Ohio, has produced a plastic rubber for filling cavities in trees.

Although Texas is a storehouse of natural gas and fuel oil, the University of Texas finds it more economical to burn lignite in its steam plant. The lignite reserves of the state are estimated at 23,000,000,000 tons, most of which remains untouched.

De-aired paving brick, which is made of clay from which the air has been exhausted by passing it through a vacuum chamber, is becoming popular because it is said to be stronger and less absorptive than the older product and can be turned out with a far smaller number of rejects.

Statistics show that 38,921,000,000 kw-hrs. of electricity was produced in the United States in 1919 at a fuel output of 3.2 pounds of coal per kw-hr. Compare this with 1.47 pounds of coal burned for each of the 85,402,000,000 kw-hrs. developed in 1933.

An electro-pneumatic horn that is self-contained is being offered by the Federal Electric Company of Chicago, Ill. The horn is mounted on top of a small motor-driven compressor and is so arranged that it can be connected to any shop fire alarm or other signaling system.

X and Y are two forms of a heat-resisting metal produced by the Kux-Lohner Machine Company of Chicago, Ill. The material is said to be well adapted for the manufacture of annealing boxes, melting pots for nonferrous metals, oven and furnace doors, fire boxes, stoker parts, etc.

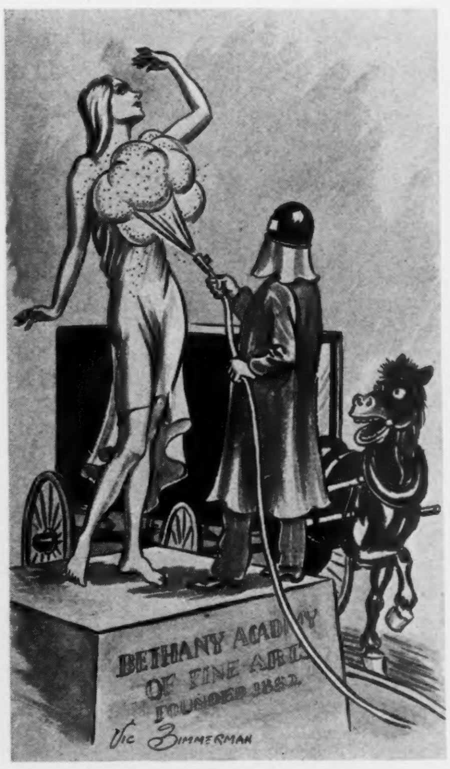
Something entirely new in glazed windows especially suitable for air-conditioned structures is being sponsored by the Libby-Owens-Ford Glass Company. The windows consist of two panes of glass so fitted in the sash as to leave an intervening air space that serves to check the flow of heat and cold. The product is called Thermopane.

To prevent contamination, many producers of foodstuffs now depend upon the metal spray gun to keep filters, coolers, tanks, mixers, and other containers in condition for use. Equipment of this kind is coated with tin, and the metallizer in question not only assures a coat of uniform thickness in the first place but makes it possible to retin worn surfaces without difficulty.

Galvanized iron or cadmium-plated surfaces treated with Granodine or Lithoform, two new products, can be given a coat of paint that will stick, says their manufacturer. Parts that are comparatively small in size are dipped in a hot bath of Granodine, while Lithoform is applied by brush or spray. The surfaces are ready for painting as soon as they have been washed and dried.

Dr. S. S. Kistler, professor of chemical engineering at the University of Illinois, has produced a light-weight insulating material which he calls "silica aerogel" and which has been described as a fine network of pure sand interlocked with air. It is said to withstand a temperature of 1,500°F.; and its insulating properties are estimated to be 10 per cent higher than those of still air and from 50 to 100 per cent greater than those of most of the materials of this kind now in use.

About six years ago, the Bureau of Standards exposed to the weather a large number of steel panels surfaced with two coats of red-lead paints. These consisted of 20, 22, 25, 28, 30, 33, 35, and 40 pounds of red lead, 95 per cent grade, to 1 gallon of boiled linseed oil without a thinner or drier; and the panels were set facing 45° south. So far the paints are standing up in the order in which they have been mentioned, the first to fail being that containing the least red lead. After a lapse of 5½ years, the last four are still in good condition.



The horse: "Gosh! Do the flies bother her, too?"

The fourth installment of the *Story of the Boulder Dam*, which is being published by the Ingersoll-Rand Company as work on this vast project progresses, is ready for distribution. This 47-page, well-illustrated booklet contains descriptions of the cofferdams, of the aerial cableways, and of the tunnels for the penstock headers, the penstocks, and the canyon-wall outlets. It also deals with the method of pouring the concrete and tells how the concrete is cooled after pouring. Copies of Volume Four can be obtained from the Ingersoll-Rand Company, 11 Broadway, New York, N. Y., which is supplying much of the compressed-air equipment used on the job.

Rubber cement sprayed on mold surfaces gave highly satisfactory results, it is reported, in making two large bronze plaques for the entrance of the National Bureau of Standards in Washington, D. C. The tablets bear legends in raised letters on a matte ground. Regular foundry practice did not produce good results for several reasons, including a slight washing of the sand. The difficulties were overcome in the bureau's experimental foundry by coating the mold walls with rubber cement. This caused the fine surface particles to adhere, thus assuring an accurate reproduction of the details of the plaque. It was possible by this procedure to cast the metal in a green-sand mold. Letter Circular No. 25, which may be obtained without charge from the bureau, describes the use of rubber cement as a binder for foundry cores.

Langley Field, Va., is to have a wind tunnel capable of resisting the tremendous forces of a gale blowing at a velocity of 500 miles an hour. The structure is to be a part of the laboratory of the National Advisory Committee for Aeronautics, and is to be 154 feet long, 51 feet wide, and 25 feet high, with a test chamber 8 feet in diameter. Its reinforced-concrete walls are to be lined with steel plates, and a total of 8,000 hp. will be required to simulate a wind of the desired velocity. With this tunnel it is proposed to study the natural laws governing air flow exceeding 200 miles an hour so as to increase airplane speeds. It has been determined through research that flying machines can make 500 miles an hour and more; but, in the absence of the knowledge that is to be sought through the medium of the new wind tunnel, the present safe speed limit is 200 miles an hour.

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